Handbook Supplement Using HP Instrument BASIC with the HP 8711B/12B/13B/14B RF Network Analyzers

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Introduction

A built-in HP Instrument BASIC (IBASIC) controller (option 1C2) can be ordered with the analyzer. An upgrade (HP model no. 86224B) is also available to add the controller to an analyzer that was not purchased with this option.

This manual describes creating and using IBASIC software on the analyzer. It demonstrates how to use IBASIC's programming, editing and debugging features. It also describes how to save and recall programs and how certain instrument-specific IBASIC features are implemented in the analyzer.

The reader should become familiar with the operation of the analyzer before programming it. This manual introduces the IBASIC operating and programming environment and provides examples of intermediate and advanced IBASIC programs. It assumes familiarity with the analyzer and HP BASIC.

Related information can be found in the following references. Contact a Hewlett-Packard sales or service office if you wish to order any of these documents. A list of HP sales and service offices can be found in the "Specifications" chapter of your *User's Guide*.

- Information on the IBASIC language, including keyword descriptions, error messages, interface specifics and programming techniques is available in the *HP Instrument BASIC Users Handbook*.
- Information on operating the analyzer is available in the analyzer's *User's Guide*.
- Information on programming the analyzer, including example programs, is available in the analyzer's *Programmer's Guide*.
- Information on the analyzer's HP-IB command mnemonics is also available in the analyzer's *Programmer's Guide*.
- Information on the SCPI (Standard Commands for Programmable Instruments) programming language is available in *A Beginners Guide to SCPI*.
- Information on using the HP-IB is available in the *Tutorial Description of the Hewlett-Packard Interface Bus*.

Overview of HP Instrument BASIC

When installed in your analyzer, HP Instrument BASIC (IBASIC) can be used for a wide range of applications, from simple recording and playback of measurement sequences to remote control of other instruments. IBASIC is a complete language with over 200 keywords.

IBASIC is a complete system controller residing inside your analyzer. It communicates with the analyzer via HP-IB commands over an internal interface bus (select code 8). It can also communicate with other instruments, computers, and peripherals using the external HP-IB interface (select code 7) or the serial (select code 9) or parallel (select code 15) I/O ports.

Note The analyzer can also be controlled by an external controller. It has a factory default external HP-IB address of 16. When using IBASIC to control other instruments, no other device should use the same address.

The external HP-IB address can be changed using either the front panel keys under the [SYSTEM OPTIONS] HP-IB menu, or the SCPI mnemonic "SYST:COMM:GPIB:ADDR".

Using HP Instrument BASIC

You need not be proficient in a programming language to successfully use HP Instrument BASIC (IBASIC). In keystroke recording mode, IBASIC automatically builds an executable program by capturing measurement sequences as they are performed. With little or no editing of these program lines, you can immediately put your program to work controlling and automating your analyzer.

IBASIC's programming interface includes an editor. Softkeys are available to allow you to run or continue a program or configure the display.

The IBASIC command set is a subset of the command set of HP BASIC. In fact, IBASIC programs can be run on any HP BASIC workstation with very few changes. When an external PC keyboard (with a DIN connector) is connected to the analyzer, the IBASIC user interface emulates the user interface of the HP BASIC. The PC keyboard can be used for command entry, editing and program inputs.

Using IBASIC, you can:

- Create on screen graphics
- Control other instruments and peripherals
- Create interactive prompts
- Simplify keystrokes with the [BEGIN] key
- Keystroke record programs
- Run applications

IBASIC also works in conjunction with an external controller which can download and run programs, query variables and respond to Service Requests (SRQs).

Typographical Conventions

The following conventions are used in this manual when referring to various parts of the HP Instrument BASIC and analyzer operation environments:

(HARDKEY)	The name of a hardkey on the front panel of the analyzer. This notation is also used to represent keys on an external keyboard connected to the analyzer's DIN interface.
Softkey	The label of a softkey.
Softkey ON off	Upper case selection in a softkey indicates the state AFTER the softkey is pressed.
(HARDKEY) Softkey 1 Softkey 2	A series of hardkeys and softkeys represents the path to a given softkey or menu.
<element>	Angle brackets are used to signify a syntax element in a statement.

2

Recording Programs

IBASIC programs for the analyzer can be created from the instrument's front panel using an external PC keyboard (option 1CL) on an HP controller running HP BASIC, or on a workstation or PC using a text editor.

Keystroke recording, described in this chapter, is ideal for creating simple programs or measurement sequences for instrument control. If a program requires data processing, decision making, or prompts for an operator or graphical setup diagrams, these must be entered using another technique. Alternative methods of program development may be used to supplement keystroke recording and create more sophisticated programs. These methods are covered in Chapter 5, "Developing Programs".

Keystroke Recording

Of all the available methods of creating IBASIC programs, keystroke recording is by far the easiest. It requires only a couple of steps to set up and run, and can be accomplished with very little knowledge of programming.

What is Keystroke Recording?

Keystroke recording is a way to automatically create IBASIC measurement sequence programs. To enable recording, simply press (SYSTEM OPTIONS) `IBASIC` `Key Record ON off`. Then press the normal key sequences of a measurement on the analyzer. Press (SYSTEM OPTIONS) `IBASIC` `Key Record on OFF` to terminate the recording. The resulting program can then be run by pressing `Run` in the (SYSTEM OPTIONS) `IBASIC` menu.

IBASIC programs communicate with the analyzer over an internal bus. They use the same set of commands used by external controllers for remote operation of the instrument. Keystroke recording works by finding the bus command, called a SCPI mnemonic, that fits each operation performed from the front panel and then building a program line to perform that operation when executed. All program lines built by keystroke recording are entered into the analyzer's program buffer. If the buffer contains no existing lines, a complete executable program will be created. If there is a program in the buffer when recording is turned on, the recorded statements are simply inserted into the existing program. Refer to Chapter 5, "Developing Programs," for a description of how to record into existing programs.

IBASIC Programs and the HP-IB Buffer

Recorded programs work by sending HP-IB commands to the instrument.

These commands are queued into an input buffer by the instrument. An IBASIC program generally outputs the commands much faster than the instrument can execute them. This often causes the program to complete while the instrument is still executing commands in the input buffer. The instrument continues processing these commands until the buffer is empty.

This may have some side-effects if you are not aware of this interaction. For example, it may not be immediately obvious that the program has actually finished, since the instrument is still functioning "remotely." This could cause confusion if you try to pause and continue a program that has actually completed.

You can clear the buffer from within your program by inserting the statement `CLEAR 8` at the beginning of your program (see Chapter 5 for information on editing programs).

Another side-effect of the speed with which the analyzer processes commands is that it is possible for a command to execute before a previous command has completed execution. The most common example of this is a data query that executes before a measurement sweep is complete. This interaction can lead to erroneous data being collected. For more information on synchronizing the execution of commands, refer to "Synchronizing the Analyzer and a Controller" chapter in the *Programmer's Guide.*

What's in a Recorded Program

If you look at any program created using keystroke recording you will find that it is composed of three fundamental IBASIC statements: `ASSIGN`, `OUTPUT` and `END`. The following simple program demonstrates these statements:

```
1   ASSIGN @Rfna TO 800
2   OUTPUT @Rfna;"SOUR1:POW -10 dBm"
10  END
```

The `ASSIGN` and `END` statements are automatically created when keystroke recording is used to create a new program (as opposed to modifying an existing one).

There will only be one `ASSIGN` statement at the beginning of a program and one `END` statement at the end, but in a typical program there will be many `OUTPUT` statements. Since the `OUTPUT` statement does the actual work of controlling the analyzer, let's take a closer look at how it is used.

Note The `ASSIGN` statement, which is automatically created, will vary depending on the model of analyzer you have:

HP 8711A,B	`ASSIGN @Hp8711 TO 800`
HP 8712B	`ASSIGN @Hp8712 TO 800`
HP 8713B	`ASSIGN @Hp8713 TO 800`
HP 8714B	`ASSIGN @Hp8714 TO 800`

The OUTPUT Statement

The IBASIC statement

```
OUTPUT <destination>; <data>
```

tells the internal computer to send some information <data> to a device at a specific address <destination>. The destination can be a device selector number (example: OUTPUT 800), or a name representing a number, called a path name (example: OUTPUT @Rfna). The data can take several forms but in recorded IBASIC programs it is a string containing commands for the instrument (a mnemonic).

Although the OUTPUT command is very flexible it is used only one way when generated by a recording. The following represents a typical OUTPUT command from a recording session:

```
OUTPUT @Rfna;"SOUR1:POW -10 dBm"
```

Notice that the OUTPUT command is followed by a name representing a device selector (@Rfna), followed by a semicolon and the data ("SOUR1:POW -10 dBm").

The ASSIGN Statement

The destination in an OUTPUT statement specifies the address of the device. In recorded programs this address is represented by the I/O path name @Rfna. The following line appears in all recorded programs before any OUTPUT statements:

```
ASSIGN @Rfna to 800
```

The ASSIGN statement allows you to substitute an I/O path name (a variable preceded by the @ symbol) for a device selector number. Therefore, after the above ASSIGN statement, the program line

```
OUTPUT @Rfna;"SOUR1:POW -10 dBm"
```

is equivalent to

```
OUTPUT 800;"SOUR1:POW -10 dBm"
```

The device selector 800 specifies the host instrument as the destination of any data sent by the OUTPUT command. The program communicates with the analyzer via select code 8, the internal HP-IB interface, which is only used for communication between IBASIC programs and the analyzer. The analyzer will respond to any address on the internal interface from 800 to 899 (800 is typically used).

SCPI Mnemonics

The data sent to the analyzer by the OUTPUT command is called a SCPI (Standard Commands for Programmable Instruments) mnemonic and is found in quotes following the device selector path name and semicolon:

```
OUTPUT @Rfna;"SOUR1:POW -10 dBm"
```

SCPI is a standard instrument control programming language providing commands that are common from one product to another, reducing the number of "device specific" commands. It

uses easy to learn, self explanatory syntax that provides flexibility for both novice and expert programmers.

The SCPI mnemonic codes used by IBASIC are the same ones used to control the instrument remotely via an external computer. External computers communicate with the analyzer over the external HP-IB bus while IBASIC programs communicate with it over the internal bus. In our example, the mnemonic `"SOUR1:POW -10 dBm"` tells the instrument to set the source power to -10 dBm.

For more information on HP-IB interfacing using IBASIC refer to Chapter 8, "Interfacing with the HP-IB." The SCPI mnemonics for the analyzer are documented in the *Programmer's Guide*.

How Recording Works

To fully understand IBASIC recording, it is important to understand the relationship between front panel instrument operation and the program that is generated to emulate that operation.

Note SCPI mnemonics entered in a program during a recording session do not have a one-to-one correlation with the actual keys that are pressed during that session.

The fact that the generated SCPI mnemonics do not exactly correspond to the keys actually pressed is important to remember. As you press a sequence of keys to perform an operation, the corresponding SCPI mnemonic for that **operation** is generated. The operation may take one keystroke or several, but the mnemonic is not generated until after a valid sequence of keystrokes is completed.

In other words, it is the functional operation of the instrument that is recorded as a mnemonic, not the keystrokes that it takes to perform that operation.

For example, recording the simple key sequence: [POWER] Level [-] [1] [0] Enter requires six keystrokes and produces only one mnemonic, `"SOUR1:POW -10 dBm"`, which is generated **after** the sequence is completed. This is then automatically formed into the command:

```
OUTPUT @Rfna;"SOUR1:POW -10 dBm"
```

and inserted into the program.

This means that if you accidentally press the wrong key in a sequence, it may not show up in the recorded program. Additionally, you cannot exactly mimic keystrokes to leave the instrument in a specific front panel state, unless it is a state that appears as a natural consequence of a completed operation.

As shown in the above example, pressing the [POWER] hardkey in a recording session has the effect of bringing up the [POWER] menu, but does not, by itself, generate a program line. You could not therefore leave the instrument with the [POWER] menu displayed.

Operations That Do Not Record

Although keystroke recording works automatically in most situations, there are some operations that cannot be captured or can only be partially captured using this method. These generally fall into one of the following areas:

- Front panel operations with no corresponding SCPI mnemonic (such as transitional key sequences).
- IBASIC front panel operations (such as some of the softkey operations found under the (SYSTEM OPTIONS) IBASIC menu).
- Operations requiring additional programming steps (such as passing control of the HP-IB to the instrument for hardcopy output).
- HP-IB operations with no front panel equivalent (such as HP-IB query commands or data transfer).
- Service menu keys (in general)

Note Do not recall programs in keystroke record mode; doing so will overwrite previously recorded program steps.

Front Panel Operations Without Mnemonics

There are some areas of front panel operation which have no corresponding SCPI mnemonics.

- Most operations on the front panel that require numeric entry allow you to use the knob to increment or decrement the current value. This will not record as a program line. You must always use the numeric keypad or step keys to enter any value if you want the operation to be recorded.
- During a measurement sequence it may take several key presses to cause an operation that will generate a mnemonic. The transitional sequences between actual instrument events are not recordable. For example: pressing the (SCALE) key displays the scale numeric entry, but nothing is recorded until you enter a value for the scale parameter.
- Any default states you setup prior to recording or encounter while recording (and consequently do not select) are not recorded.
- Use of step keys are not recommended because the results may depend on the function's step size, which may change as other parameters change.

Note Instrument states that are not specifically selected or changed are not recorded.

Since these default states are not recorded, you must either actively select them to generate a program statement or make sure the instrument is in the same exact state when the program is run as when it was recorded. This is discussed further in the "Avoiding Recording Errors" section of this chapter.

HP Instrument BASIC Operations

Some softkeys under the (SYSTEM OPTIONS) IBASIC menu cannot be recorded. Operations on programs, such as Run, Continue, Edit and (SAVE RECALL) Programs, do not record. You can, however, record display partitions and all other save and recall operations not having to do with IBASIC programs.

Although IBASIC operations cannot be recorded, many do have corresponding SCPI mnemonics that allow an external controller to control and communicate with internal IBASIC programs. For more information refer to Chapter 8, "Interfacing with the HP-IB."

Operations Requiring Additional Programming

Some operations that work well when performed from the front panel have circumstances that require special attention when used in a program. This is due to two kinds of problems, synchronization and active control.

Synchronization

Timing and synchronization must always be anticipated where one event must complete before another can occur. One example of this is when you need to detect a state in the instrument before issuing the next command. For example, suppose you want your program to perform a limit test on data, but only after a sweep has been completed. You can record the command to perform the limit test by pressing key sequences. However, to detect when the instrument has completed a sweep, you must edit the program and include a routine that waits for a status register to indicate the end of the sweep.

Note Synchronization is only a problem with **overlapped** commands (such as the command to trigger a sweep), that is commands that don't hold off the processing of subsequent commands. The analyzer adds an extra command `*WAI` when an overlapped command is created using keystroke recording. `*WAI` prevents the analyzer from executing any further commands until the overlapped command has finished. For more information on synchronization see the "Synchronizing the Analyzer and a Controller" chapter in the *Programmer's Guide*.

Active Control of the HP-IB Interface

Some operations require the analyzer to be the active controller on the external HP-IB bus. This generally means that the analyzer must be the System Controller (or active control must be passed to it from an external controller, if one is connected). When an IBASIC program begins running, however, the instrument's active control of the external interface is automatically passed to the program, so active control must be passed back to the analyzer before these operations can be performed.

These operations include all of the following actions when they are directed to HP-IB devices. Note that active control of the HP-IB interface is only a problem if that bus is being used. Hardcopy output to devices on the serial or parallel ports do not require control of the HP-IB.

(HARD COPY) `Start`

(HARD COPY) `Abort`

(SAVE RECALL) `Select Disk` `External`

(SAVE RECALL) `Save State` or `Re-Save State` (to external disk)

(SAVE RECALL) `Recall State` (from external disk)

(SAVE RECALL) `Save ASCII` `Save Chan 1` or `Save Chan 2` (to external disk)

You can keystroke record any of these operations but you will not be able to successfully run the program that is generated. You will need to enter the program lines necessary to first pass control to the analyzer and then wait for control to be passed back to the program.

See the "Passing and Regaining Control" section of Chapter 8 for an example of passing control to the analyzer.

Mnemonics With No Corresponding Front Panel Operation

Several of the analyzer SCPI mnemonics for the instrument perform operations that are not available from the front panel and which, therefore, cannot be recorded. These include operations such as querying instrument status, transferring data over HP-IB, setting and clearing status registers and general HP-IB housekeeping.

These operations are useful for the more advanced HP-IB programmer using IBASIC. Because they fall outside the direct operating realm of the analyzer, they cannot be recorded. They can be added to a recorded program using the built-in editor or another editing environment. See the *Programmer's Guide* for a complete description of the analyzer's HP-IB command set. See also "Built-In High Speed Subprograms" in Chapter 9.

Avoiding Recording Errors

Use Instrument Preset

In most cases, it is recommended that the (PRESET) key/operation be recorded as the first keystroke recorded. This sets the instrument to its default state and avoids the risk of creating a program that depends on instrument settings that were present at the time of the keystroke recording but may be different when the program is run.

You can include the command to perform a preset in your program by pressing (PRESET) immediately after turning recording on. This inserts the following line prior to all other OUTPUT statements in your program:

```
OUTPUT @Rfna;"SYST:PRES;*WAI"
```

Specifically Select Parameters

If you do not want the instrument preset before a recorded program is run (for example, you may be recording a section of a larger measurement sequence), be sure to specifically activate every instrument setting that you will need in your automated sequence. For example, if you want the data format to be Log Mag, press (FORMAT) and then Log Mag, even though Log Mag is already the default setting. This will generate a program line to specifically set the data format to Log Mag.

In some cases you may have to select another setting first and then re-select the original setting in order to generate the correct program line. For example, if you want to generate a program line to set the sweep trigger to Continuous, and you discover that it is already set to Continuous when you start recording, press (MENU) Trigger Hold first — then press Continuous. You can easily remove unwanted program lines generated by this procedure in the editor.

Note Do not rely on the step keys or front panel knobs to set parameters. Use of step keys are not recommended because the results may depend on the function's step size, which may change as other parameters change.

Use HP-IB Echo

HP-IB Echo is a useful analyzer feature that allows you to view the SCPI mnemonic or mnemonics corresponding to any operation executed from the front panel. To turn on HP-IB Echo, press (SYSTEM OPTIONS) HP-IB and HP-IB Echo ON off. After doing this you will see a mnemonic appear in a dialogue box on the screen as you complete any key sequence that has a matching SCPI mnemonic.

This is the exact mnemonic that is generated in your recorded program during a recording session.

Using HP-IB Echo you can preview the SCPI mnemonic commands that will be stored in your program before you actually record them. While this is not essential, it can be very useful when you are in doubt as to what a particular key sequence will record, or precisely when a key sequence corresponding to a mnemonic is completed.

3

Running, Pausing and Stopping Programs

Program control — running, pausing and stopping an IBASIC program — can be managed from the analyzer front panel using various hardkeys and softkeys. These actions and their corresponding keys are described in this chapter.

A special case is an autostart program which runs automatically on power-up if it exists on the analyzer's built-in floppy disk drive or RAM disk.

IBASIC programs may also be remotely controlled via SCPI commands over the HP-IB. For information on running, pausing and stopping programs from an external controller see Chapter 8, "Interfacing with External Devices."

Starting Programs Automatically

When the analyzer is powered up, it automatically searches first the internal non-volatile RAM disk and then the built-in floppy disk drive for a program named `AUTOST` or `AUTOST.BAS`. When an `AUTOST` program is found, it is automatically loaded and executed.

The `AUTOST` program can be used for anything from configuring the analyzer for specific measurements, much like an internal instrument state Save/Recall register, to diagramming measurement setups using graphics commands, as in a guided measurement sequence.

Refer to Chapter 4, "Saving and Recalling Programs," for information on using the analyzer to name programs before they are saved.

Running and Continuing a Program

To run an IBASIC program that is already in the analyzer program buffer, press the Run softkey in the [SYSTEM OPTIONS] IBASIC menu. The `RUN` command can also be executed from an external keyboard in either of two ways.

- Press the function key [F1] that corresponds to the Run softkey (see note below).
- Type `RUN` on a command line and press [Enter]. A command line is always available when an IBASIC display is partitioned. (See Chapter 5, "Developing Programs" for information about display partitions.) You can also activate a command line from an external keyboard with no IBASIC displays partitioned by pressing the [ESC] key on your external keyboard.

Note When an external keyboard is connected, its function keys F1 through F8 always represent the analyzer's eight softkeys. The analyzer's hardkeys are each represented by a combination of Shift or Ctrl and one of the function keys. Refer to the analyzer's *User's Guide* for more information on the external keyboard interface. The SYSTEM OPTIONS IBASIC menu can be accessed from an external keyboard using Ctrl + F3 (for SYSTEM OPTIONS) and F1 (for IBASIC). A keyboard template showing which keys to press for specific analyzer functions was supplied with your analyzer. (HP part number 08712-80004.)

The RUN command is executed in two phases: prerun initialization and program execution.

The prerun initialization phase consists of:

- Reserving memory space for variables specified in COM (both labeled and blank), DIM, REAL or INTEGER statements, or implied in the main program segment. Numeric variables are initialized to 0; string variables are initialized to the null string.
- Checking for syntax errors that require more than one program line to detect. Included in this are errors such as incorrect array references, and mismatched parameter or COM lines.

After prerun has been successfully completed, the program will begin the execution phase. Program lines will be executed until one of the following events occurs:

1. An END or STOP statement is encountered in the program.
2. The PRESET hardkey is pressed to reset the instrument.
3. The Pause softkey is pressed to pause the program.
4. A PAUSE statement is encountered in the program.

Pausing a Program

When an IBASIC program is running on the analyzer a softkey menu is always available. This "Program Running" menu has seven user-defined softkeys and a Pause softkey. Press the Pause softkey to suspend execution of a program. Pause is the eighth softkey and is represented by F8 on an external keyboard.

The program can also be paused by inserting a PAUSE statement in the program. The instrument responds as if you had pressed the Pause softkey. Refer to Chapter 5, "Developing Programs," to learn how to insert statements in your recorded program. Note that PAUSE is one of the IBASIC keywords included in the editor's label window (also described in Chapter 5).

To continue the program from a paused state, press the `Continue` softkey in the (SYSTEM OPTIONS) `IBASIC` menu or (F2) on an external keyboard. This menu automatically appears when a program is paused. Continuing a paused program resumes program operation from where it was paused, retaining the current program context (variable values, etc).

Pausing a program does not close any files that have been opened by the program. You will not be able to perform any of the following disk operations after pausing a program that has left a file open on that medium:

- RENAME FILE
- DELETE FILE
- DELETE ALL FILES
- COPY FILES
- COPY DISK
- FORMAT DISK

To close all open files, you must complete the execution of the program or perform an IBASIC RESET. This can be done by pressing the (PRESET) hardkey. The (PRESET) hardkey is represented by (Ctrl) + (F4) on an external keyboard. Keystroke recorded programs do not open files and therefore avoid this problem.

Stopping a Program

To stop a program completely, press the (PRESET) hardkey at any time while the program is running. This causes an IBASIC RESET. Placing a STOP statement in your program will also terminate the program, but does not perform an IBASIC RESET operation. The END statement can also be used to stop program execution, but it must be the last line in the main program segment.

The program remains in the program buffer after execution stops until it is cleared. To clear the program buffer, press (SYSTEM OPTIONS) `IBASIC` `Utilities` `Clear Program` or turn off the instrument.

For more information on the PAUSE and STOP statements see the "HP Instrument BASIC Language Reference" section of the *HP Instrument BASIC Users Handbook*, contained in this binder.

4

Saving and Recalling Programs

IBASIC programs can reside in memory, on disk, or in an external computer.

To transfer a program between the instrument's buffer and a disk mass storage device, use the (SAVE RECALL) Programs menu. To access the (SAVE RECALL) Programs menu using an external keyboard, use (Ctrl) + (F1) (for (SAVE RECALL)) and (F5) (for Programs).

The `GET`, `SAVE`, `LOAD`, `STORE`, `RE-STORE`, and `RE-SAVE` commands can be used within a program or from an IBASIC command line to transfer program files to and from mass storage. An autoload feature also exists to allow for a program (named `AUTOST` or `AUTOST.BAS`) to be automatically recalled from the internal non-volatile RAM disk or the built-in floppy disk and run at power-up.

Another mode of program transfer is between the analyzer and an external controller, such as an HP Series 200/300/700 controller. Using an external controller, you can combine the convenience of keystroke recording in IBASIC with the ease of program editing in a dedicated external workstation by recording the measurement sequence and then uploading the program to the external controller for further editing. Fully developed programs may be downloaded from an external controller as well. The methods of transferring programs between the analyzer and an external controller are described in detail in Chapter 8, "Interfacing with External Devices."

This chapter describes all program transfer operations between the program buffer and the analyzer internal non-volatile RAM disk, internal volatile RAM disk, internal floppy disk drive and external mass storage devices (disk drives).

Note The IBASIC file system can work with both LIF (Logical Interchange Format) and DOS (Disk Operating System) formatted disks. When it catalogs or loads files from a disk, the analyzer automatically recognizes the correct disk format.

Selecting a Disk

When the (SAVE RECALL) **Programs** menu is selected the analyzer automatically catalogs the selected disk or memory. The selected disk is one of the following mass storage devices:

- Internal Non-Volatile RAM Disk
- Internal Volatile RAM Disk
- Internal Floppy Disk Drive
- External Disk Drive

To select a mass storage device press the **Select Disk** softkey in the (SAVE RECALL) menu. Then press the key corresponding to your choice. The HP-IB address of the external disk drive is set under the (SAVE RECALL) **Select Disk** **Configure Ext. Disk** menu.

Saving a Program

To save the current contents of the analyzer program buffer to a file, press **Save Program** in the (SAVE RECALL) **Programs** menu. If desired, specify the type of file, binary or ASCII, with the **File Type** softkey; default is ASCII. The program is saved to an ASCII file with a default name on the currently selected mass storage device or disk. Each time the **Save Program** key is used a new file is created. These files are named `PROG0.BAS`, `PROG1.BAS`, ... with the number being changed for each new file. For portability, save files in ASCII.

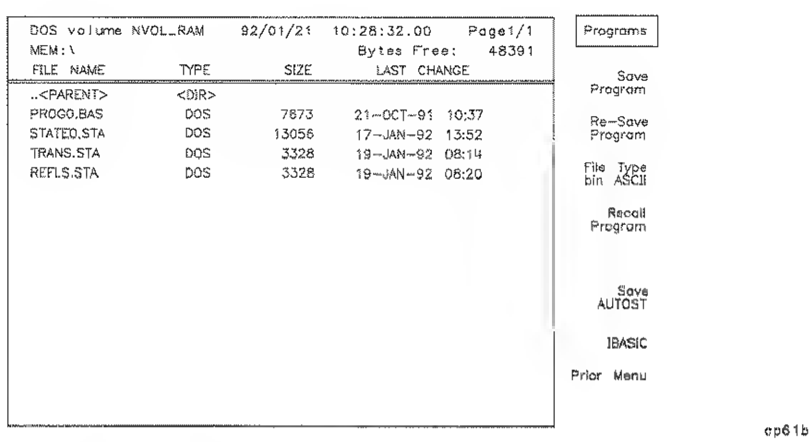


Figure 4-1. The (SAVE RECALL) Screen

If you are re-saving a program — that is, saving a file to a disk that already contains the file name — press (SAVE RECALL) Programs and use the arrow keys to highlight the name of the file to be re-saved. Then press Re-Save Program and the file is saved. The disk is automatically catalogued when the (SAVE RECALL) menu is selected.

The Re-Save Program softkey can also be used to save a new program with a non-default file name. Press Re-Save Program. Enter the new program's name using the external keyboard or the internal label maker. If no file with that name exists on the disk a new file is created.

AUTOST Programs

IBASIC allows you to designate a program to be automatically loaded and run when the instrument is first powered up. To make an autoloading program save it with the file name `AUTOST` on the internal floppy disk drive or internal non-volatile RAM disk. This can be done from the (SAVE RECALL) Programs menu by pressing Save AUTOST or by using the Re-Save Program softkey and entering the file name `AUTOST`.

When the analyzer is powered up, it automatically searches first the internal non-volatile RAM disk and then the built-in floppy disk drive for a program named `AUTOST` or `AUTOST.BAS`. When an `AUTOST` program is found, it is automatically loaded and executed.

Recalling a Program

To recall a program file from mass storage to the program buffer, use the (SAVE RECALL) Programs menu to catalog the disk. Select the desired mass storage device or disk, use the arrow keys to highlight the file and press Recall Program.

The recalled program file is entered into the program buffer one line at a time and checked for syntax errors. Lines with syntax errors are commented out and the IBASIC syntax error is displayed briefly in an error message and written to the CRT at the same time. To view error messages logged to the CRT, use the (SYSTEM OPTIONS) IBASIC IBASIC Display menu to allocate a screen partition for IBASIC.

Note Any program recalled to the program buffer using the (SAVE RECALL) Programs menu will overwrite the current contents of the program buffer. Be sure to save your current program before recalling another program from disk.

5

Developing Programs

For many applications, you can use keystroke recording to create and run programs without needing to alter the program code that is generated. However, with some knowledge of the IBASIC language and the program development capabilities of the analyzer, you can significantly increase the power of your recorded programs or create your own programs from the ground up.

This chapter describes the operation of the following keys in the (SYSTEM OPTIONS) `IBASIC` menu, and any softkeys found in their underlying menus:

- `Edit`
- `IBASIC Display`
- `Utilities`

`Edit` places you in the editor where you can make changes to your program on a line-by-line basis.

`IBASIC Display` menu allows you to select what part, if any, of the CRT display is available for the use of IBASIC. An IBASIC display partition provides you with a command line you can use to execute IBASIC commands from an external keyboard. It also provides an area for viewing graphics and program output.

`Utilities` allows you to Clear Programs from the program buffer, allocate memory for program use, or secure program lines.

External Editors

In addition to using the built-in IBASIC editor, programs can be developed in the following external environments.

- HP BASIC editors
- ASCII word processors

The external editing environments provide many advantages, the most notable being speed and flexibility. Precautions must be taken when using ASCII word processors because they do not provide the syntax checking available when using the internal editor.

After editing a program in an external environment, the best practice is to `GET` the program from an IBASIC command line using the following procedure (instead of using the (SAVE RECALL) keys described in Chapter 4).

1. Partition an IBASIC display (as described later in this chapter).
2. Use an external keyboard to enter the command `GET "PROGO:,4"` (this command loads a program file `PROGO` from the internal floppy disk drive).
3. Watch the IBASIC display as the program is loaded — syntax errors result in error messages displayed on the screen.
4. Edit the program to correct any errors found.

HP BASIC

The HP BASIC editor checks for the syntax of the version of HP BASIC being used. Because IBASIC is a subset of HP BASIC it may not find all of the errors — the most common error is the use of HP BASIC commands that are not supported by IBASIC. For a listing of the commands supported by IBASIC refer to Chapter 10, "IBASIC Keyword Summary".

ASCII Word Processors

When an ASCII word processor is used to edit a program no syntax checking occurs until the program is loaded by the instrument. Another complication with using a word processor is that program line numbers are not automatically renumbered when new lines are inserted.

It is recommended that you renumber the program, as described later in this chapter, to reduce the possibility of errors. Errors in numbering lines usually do not result in a syntax error, they write over other program lines.

Editing Your Program Using Edit

The built-in editor may be used for creating and altering lines in an IBASIC program. Those familiar with the editor found in HP BASIC will find it somewhat similar to the instrument's IBASIC editor; others should find it easy to learn and use. This section tells you how to edit and enter an IBASIC program.

To start the editor, press the Edit softkey in the (SYSTEM OPTIONS) IBASIC menu or (F4) on an external keyboard. You will see the program appear on the display with a cursor on the first line of the program, as shown in Figure 5-1. If the program buffer is empty, the first line number 10 appears with the cursor positioned to begin entering text.

```
CALL PRINT ABORT SUB SUBEND DATA LOCAL DIM BIT ABCDEFGHIJKLM      Edit
  10     !===================================================
                                                                Insert
  20     ! This program measures the transmission and             Line
  30     ! reflection characteristics of a bandpass filter
  40     !===================================================   Insert
  50     ASSIGN @Hp8711 TO 800                                    Char
  60     ON KEY 0 LABEL "TRAN" CALL Transmission
  70     ON KEY 1 LABEL "REFL" CALL Reflection                  Delete
  80     ON KEY 3 LABEL "SETUP" CALL Setup_diag                   Line
  90     ON KEY 5 LABEL "EXIT" GOTO End_prog
 100     LOOP                                                   Recall
 110       DISP "WAITING FOR SELECTION"                           Line
 120     END LOOP
 130 End_prog:DISP                                              Delete
 140     END                                                      Char
 150     !===================================================
 160     SUB Transmission                                        Enter
 170 Transmission: !
 180     OUTPUT @Hp8711;"CONF 'FILT:TRAN'"
 190     OUTPUT @Hp8711;"DISP:ANN:FREQ1:MODE CSPAN"
 200     OUTPUT @Hp8711;"SENS1:FREQ:CENT 175 MHZ"
                                                            Prior Menu
```

Figure 5-1. The HP IBASIC Program Editor

The analyzer editor is accompanied by a "Label Window" at the top of the screen. This window is filled with characters and IBASIC keyword commands and has its own cursor.

The current program line (the line containing the cursor) always appears as two lines on the screen, allowing you to enter up to 108 characters if needed. All other lines have only their first 51 characters displayed (excluding line numbers).

Each line has a numeric field in the first 6 columns in which program line numbers are right justified. Although program lines are automatically numbered by the editor, you can edit the current line number to copy or move it to a different location in the program. The range of line numbers is from 1 to 32767. To end an editing session press the Prior Menu softkey in the edit menu or (F8) on an external keyboard. This will return you to the (SYSTEM OPTIONS) IBASIC menu.

The IBASIC Editor Softkeys

The editor has two sets of softkey menus, the **Edit** keys and the **Character Entry** keys. The edit menu is activated when you press (SYSTEM OPTIONS) IBASIC Edit. The menu box above the softkeys shows the label **Edit**.

The edit menu provides the following softkeys:

Insert Line	((F1))
Insert Char	((F2))
Delete Line	((F3))
Recall Line	((F4))
Delete Char	((F5))
Enter	((F6))
	((F7))
Prior Menu	((F8))

The character entry menu is described in the "Editing from the Front Panel" section of this chapter.

Recording into an Existing Program

One way to enter lines into your program is to use the keystroke recording capabilities of IBASIC. To record measurement sequences or other front panel operations into your program follow the procedure described below.

1. Activate the editor by pressing (SYSTEM OPTIONS) IBASIC Edit.
2. Use the step keys on the analyzer or the cursor keypad on an external keyboard to position the cursor on the line above which you want the recorded statements inserted.
3. Press Prior Menu to exit the editor.
4. Press Key Record ON off to activate keystroke recording.
5. Record the measurement sequence or front panel operation.
6. Press (SYSTEM OPTIONS) IBASIC Key Record on OFF to conclude the recording session.

The inserted recording acts the same as if you had pressed Insert Lines in the editor, and generated `OUTPUT` statements in insert mode.

Note The `ASSIGN @Hp8711 to 800` statement is **NOT** generated when you are recording into an existing program and **MUST** be included in your program prior to any recorded `OUTPUT` commands. If you initially created the program using recording, this statement should already exist. If it does not exist, you will need to enter it.

Editing with an External Keyboard

With an external keyboard connected to the analyzer, it is easy to edit or create an IBASIC program using the internal editor. Note that the Front Panel Editor described in the next section is always available, even when an external keyboard is in use.

Note The analyzer and the IBASIC editor work with IBM PC-AT compatible keyboards (US only) that have a standard DIN interface. Non-US language keyboards will not cause an error, they simply will not be recognized as different from the US keyboard. A compatible keyboard can be purchased by ordering option 1CL with the analyzer. Keyboards with a mini-DIN connector will need a mini-DIN to DIN adapter, HP part number C1405-60015.

The PC-AT keyboard, Figure 5-2, has four major key areas: the typewriter keypad, the numeric keypad, the cursor keypad, and the function keys. Alphanumeric text can be entered using the typewriter and numeric keypads as needed. The cursor keypad can be used to move the cursor up/down a line or left/right to the next character positions. The function keys of the keyboard map to the softkeys on the analyzer front panel.

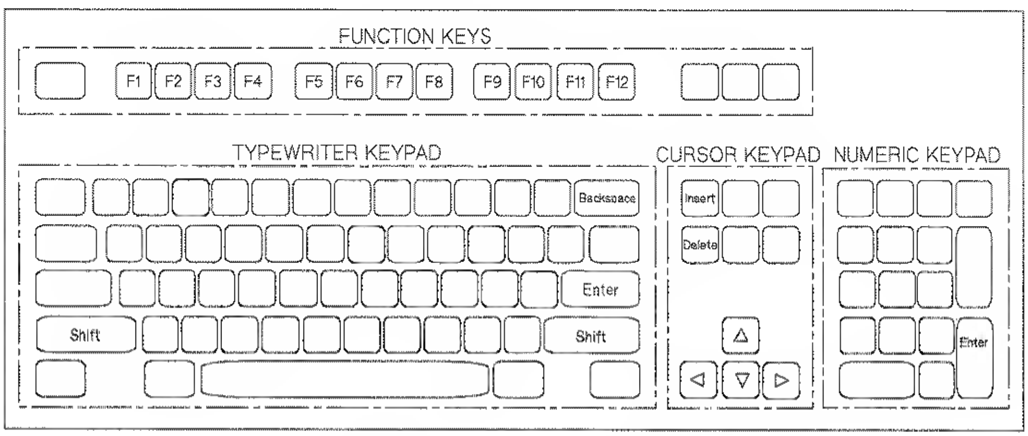


Figure 5-2. The PC Keyboard

Connect the keyboard to the rear panel DIN connector of the analyzer with the power off. Turn on the power and load the IBASIC program to be edited. Select the [SYSTEM OPTIONS] `IBASIC` `Edit` menu and use the cursor keypad to position the cursor within the program for editing operations. The Page Up and Page Down keys on the keyboard scroll through the program quickly and easily.

Inserting Lines

Insert one or more program lines above an existing line by placing the cursor on that line and pressing (Shift) + (Insert) on the keyboard. This key combination functions as a toggle to turn insert mode on and off.

As an example, assume you want to insert some lines between two adjacent program lines numbered 90 and 100. Place line 100 in the current line position and press (Shift) + (Insert). The program display "opens" and a new line, number 91, appears between line 90 and line 100. Enter the inserted line and another inserted line, number 92, will appear. If, after continuing to enter lines in this manner, the inserted line number increments to 100, then the current line 100 will be renumbered one higher to accommodate the inserted line.

To stop inserting lines either press (Shift) + (Insert) again or use the cursor keys to move to another program line. Make sure you have entered any changes to your final inserted line (with the (Enter) key) before exiting the insert mode. Remember any changes you have made to the current line will be lost if you move the cursor to another line without pressing (Enter).

Editing Lines

Use the cursor keypad on the keyboard to move around the program for editing. The left and right arrow keys move within a program line while the up and down arrow keys move between lines. The alphanumeric keypad on the keyboard can be used for entering or editing text. Another key that is useful is the (Delete) key, which deletes the character highlighted by the cursor.

When you finish editing or changing a program line, store it into the program by pressing (Enter) on the keyboard. The computer checks the line for syntax errors and converts letter case to the required form for names and keywords (IBASIC commands). If no errors are detected, it then stores the line in the program buffer.

Entering Program Lines

When you finish entering or changing a program line, to store it into the program buffer you must ENTER it in one of four ways:

1. Use the (ENTER) key on the front panel of the analyzer.
2. Use the Enter softkey on the instrument.
3. Use the (Enter) or (Return) key on the external keyboard.
4. Use the function key on the keyboard ((F6)) that represents the analyzer's Enter softkey.

The computer checks the line for syntax errors and converts letter case to the required form for names and keywords (IBASIC commands).

If no errors are detected, it then stores the line.

Note If you edit or enter text on the current program line and then move off the line without pressing ENTER, all editing on the line will be lost.

Editing from the Front Panel

Use the step keys to move the cursor up and down the lines in the program. When the cursor is located at the beginning of a line you want to change, use the knob to position the cursor within the line.

Character Entry

The character entry menu and the associated label window are activated by pressing the `Insert Line` or `Insert Char` softkeys. The knob and step keys now move the cursor in the label window.

Use the knob or step keys to move the label window's cursor until it highlights the desired letter or keyword and press `Select Char/Word`. Continue editing until the line is correct. Press `Enter`. The computer checks the line for syntax and then stores it in the program if the syntax is correct. Press `Prior Menu` to return to the edit menu.

The character entry menu provides the following softkeys:

`Select Char/Word`	(F1)	Inserts the character or word highlighted by the label window cursor at the position marked by the program cursor.
`Space`	(F2)	Inserts a space at the position marked by the program cursor.
`Delete Char`	(F3)	Deletes the character highlighted by the program cursor.
`Backspace`	(F4)	Deletes the last character before the program cursor.
`Enter`	(F5)	Enters the edited program line.
`Prior Menu`	(F8)	Returns to the edit menu and de-activates the label window.

The Label Window

The label window is a scrolling list of the most common characters, symbols and keywords used in IBASIC programming. It contains the uppercase alphabet, the numbers 0 to 9, symbols such as single and double quotation marks, parentheses, signs for mathematical and string operations as well as numerous other characters and symbols.

It also contains the following IBASIC keywords:

ABORT	ENTER	NOT
ASSIGN	FOR	OUTPUT
BIT	GOTO	PAUSE
CALL	IF	PRINT
CLEAR	INPUT	SUB
DATA	INTEGER	SUBEND
DIM	LIST	THEN
DISP	LOCAL	TO
END	NEXT	WAIT

Inserting Lines

To insert one or more program lines above any existing line, place the cursor on the existing line and press `Insert Line`. This causes the cursor to move to a new line that appears above the existing one. Enter and store the inserted line and another inserted line will appear. Remember, each line must be ENTERed or any changes will be lost when the cursor is moved to a different line.

Removing Program Text

You can remove individual characters or entire lines from within the editor.

Deleting Characters

The `Delete Char` softkey removes the character under the cursor and moves all characters to the left one place. Repeatedly pressing `Delete Char` will cause text to the right of the cursor to be removed one character at a time. The `Delete Char` softkey functions the same in both the line number and program statement fields. When used in the line number field, it deletes only line numbers to the right of the cursor (not program statement characters).

When using an external keyboard there are other keys that perform the same function as the `Delete Char` softkey. These are the (Delete) key in the cursor keypad and the function key that maps to the appropriate softkey, (F5) for the edit menu or (F3) for the character entry menu.

Another way to remove text on a line is by backspacing. Pressing the (– / ←) hardkey or the `Backspace` softkey on the front panel of the analyzer removes the letter to the left of the cursor and moves the cursor (and all characters to the right of the cursor) one space to the left. The (F4) function key or the (Backspace) key on the typewriter keypad of the external keyboard perform the same function. When the cursor is on a line number, using backspace simply moves the cursor back one position without deleting the number.

Deleting Lines

The `Delete Line` softkey allows you to remove the current program line. When the current program line disappears, all subsequent lines in the display move up one line, but are not renumbered. The cursor maintains its column-relative position on the next highest numbered line.

If `Delete Line` is pressed when the cursor is on the last program line, the line text is removed but the line number remains with the cursor resting in the first column of line. This puts the editor in insert mode on the last line of the program (see "Inserting Lines"). (To get out of insert mode, simply move the cursor up one line.)

Pressing `Delete Line` will **NOT** remove a subprogram line with the `SUB` keyword in it unless all program lines belonging to that subprogram have already been deleted. A block of program lines can be deleted by executing the command `DELETE x,y` from an IBASIC command line (where `x` is the first line number in the block and `y` is the last line number).

When using an external keyboard there are other keys that perform the same function as the `Delete Line` softkey. These are (Shift) + (Delete) in the cursor keypad and the function key ((F3)) that maps to the `Delete Line` softkey in the edit menu.

Recalling a Deleted Line

The last line that was deleted using `Delete Line` is buffered in the analyzer. To recall this line press the `Recall Line` softkey or (F4) on an external keyboard. Press `Enter` to restore the line to the program.

Renumbering, Copying, Moving, and Indenting Lines

If you want to change the line number of an edited program line, simply move the cursor to the line number field and enter the line number you want. Changing the line number causes a copy operation, not a move. Therefore, if you only want to move the line, change the line number first, press `Enter` and then delete the original line. If you want to create an edited copy of the current line, edit the line and then change the line number and press `Enter`. The edits will only appear in the copied line.

If you are inserting a program line and you change the line number, the line will move to its new location when you ENTER it. The editor will remain in insert mode at the new location in the program.

You will notice that when the cursor is in the line number field, entries operate in an overtype fashion rather than in the insert fashion as in the text portion of the program line. Also the (←) (backspace) key simply moves the cursor over line numbers without deleting the number.

Note To renumber the entire program, IBASIC supports the RENumber command *BUT* you need an external keyboard to execute it. The command can be executed by following the steps listed below.

1. EXIT the edit mode by pressing `Prior Menu` until the (SYSTEM OPTIONS) `IBASIC` menu is active.
2. Partition an IBASIC display as described next in this chapter.
3. Enter the command `REN x,y` (where x is the new beginning line number and y is the increment) from the command line of the IBASIC display.
4. Another way to "renumber" program lines with an external keyboard is to use the COPYLINES and MOVELINES commands. Use the INDENT command to make your code more readable.

Using IBASIC Display

Pressing the (SYSTEM OPTIONS) IBASIC IBASIC Display softkey ((F7) on an external keyboard) allows you to allocate a partition of the analyzer's display to be used by your program or, alternately, to return any allocated partition to the analyzer.

The analyzer display is divided into two small partition areas (Upper and Lower) or one large area (Full), which encompasses both the Upper and Lower partition areas.

All screen output commands, such as PRINT and DRAW, require that you allocate a partition of the screen in order to view the results of the command. This can be performed in your program or interactively using the IBASIC Display softkey. Allocating display partitions can be accomplished from within your program using the SCPI mnemonic "DISP:PROG" and specifying the parameter UPPER, LOWER or FULL. For example the statement

```
OUTPUT 800;"DISP:PROG FULL"
```

allocates the entire display, corresponding to selecting Full from the IBASIC Display menu.

An IBASIC display partition cannot occupy the same location as a measurement channel display. When an IBASIC display is partitioned it limits the amount of the CRT available to simultaneously show measurement data. Table 5-1 shows the IBASIC Display menu softkeys, their corresponding SCPI mnemonics, their functions and the measurement data that can be viewed when the display partition is allocated.

Table 5-1. IBASIC Display Partitions

SOFTKEY	SCPI MNEMONIC	ALLOCATES	VISIBLE DATA
None	DISPlay:PROGram OFF	No Display	Channels 1 and 2
Full	DISPlay:PROGram FULL	The Whole Display	None
Upper	DISPlay:PROGram UPPer	Upper Channel Area	Channel 2 only
Lower	DISPlay:PROGram LOWer	Lower Channel Area	Channel 1 only

Note

When the UPPER or LOWER display partition is selected, the measurement display automatically selects the "split-screen" format. This format uses half of the CRT to display each channel's measurement data. Channel 1 data is always shown on the upper half of the screen, channel 2 data is shown on the lower half. The split-screen format allows measurement data to be viewed simultaneously with IBASIC program output. For more information about the split-screen format, or other parts of the measurement display, refer to the analyzer *User's Guide*.

Most display allocation should be handled by your program via the SCPI mnemonics. These softkeys are best utilized during program development.

An IBASIC partition can be very useful during program development. It can be used to view program output, to query variables and to execute IBASIC commands (such as `GET` and `REN`) outside of your program. Figure 5-3 shows the relative size and location of the different IBASIC partitions and their command and display lines.

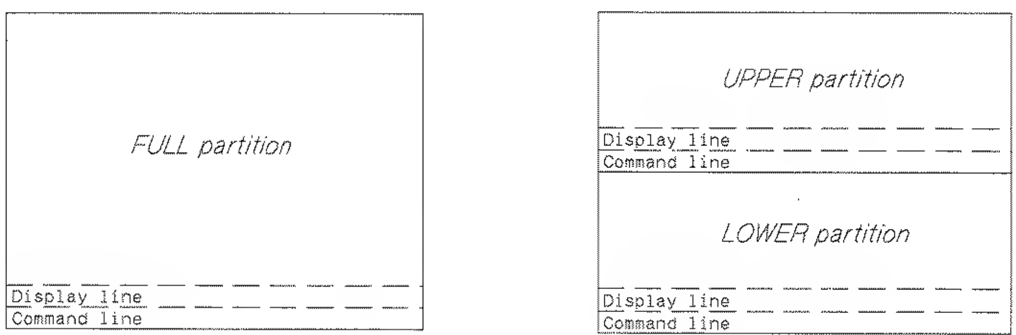


Figure 5-3. The IBASIC display partitions

More information about using display partitions within a program is available in Chapter 7, "Graphics and Display Techniques."

Using `Utilities`

Pressing the (System Options) `IBASIC` `Utilities` softkey (F6 on an external keyboard) allows you to clear the program buffer, allocate memory for program use, or secure your program.

- Clear Program (F1)
- Memory Size (F2)
- Secure (F3)

Executing the `Clear Program` erases the current program buffer and frees all memory currently allocated. Memory size (see below) is reset to 8192 bytes. You will be prompted to ensure you do not accidentally erase the program.

`Memory Size` allows you to set stack memory to be used by your program. At power up it is set by default to 8192 bytes. However, when a program is (RUN), the analyzer will try to automatically set the Memory Size large enough to accommodate the program's Stack and COM memory requirements.

For some programs the automatic memory sizing will be too small and you will get the message:

```
Error 2 in 100 Memory overflow
```

When this error occurs, you must manually set the `Memory Size` to the value in bytes required by your program, up to the available memory in your system.

`Secure` is used to secure lines of your program. Secured lines cannot be listed, edited, or displayed. After you press this key you will see:

- Start Line # (softkey 1)
- End Line # (softkey 2)
- Perform Secure (softkey 4)

After you have set the start and stop line numbers, execute the `Perform Secure` operation.

Caution Once you have secured your program lines, there is no way to remove the security. Therefore, do not secure the only copy of your program. Make a copy of your original program, `Secure` the copy, and keep the original in a safe place. This prevents unauthorized users from listing your program.

6

Debugging Programs

The process of creating programs usually involves correcting errors. You can minimize these errors by using keystroke recording for measurements and other front panel sequences and by writing structured, well-designed programs.

Of course bugs can and do appear in even the best designed programs and IBASIC contains some features that can help you to track them down. Some IBASIC capabilities useful for program debugging are simple and, used properly, can be very helpful. Some of these capabilities are:

- RUN or CONTINUE your program
- STEP through your program, executing one line at a time
- Display the last error encountered in your program
- Examine program variables

By examining the values assigned to variables at various places in the program, you can get a much better idea of what is really happening in your program.

By inserting a PAUSE statement in your program you can pause the program at any line and then examine the values of variables at that point in the program. You can then press Continue in the (SYSTEM OPTIONS) IBASIC menu to resume operation to the next PAUSE statement (or the program end).

These capabilities can be used together to effectively examine the program's operation and solve your particular problems.

Note Most of the debugging techniques described in this chapter make use of an external keyboard. The analyzer and the IBASIC editor work with PC-AT compatible keyboards (US only) that have a standard DIN interface. Non-US language keyboards will not cause an error, they simply will not be recognized as different from the US keyboard. A keyboard can be ordered with the analyzer by ordering option 1CL.

Setting Breakpoints

A common method of debugging a program involves the use of breakpoints. A breakpoint causes the program to stop before executing a specified line so that you can examine the program state at that point. In IBASIC this can be accomplished by inserting `PAUSE` statements in the program code. Note that `PAUSE` is one of the IBASIC keywords included in the editor's label window (described in Chapter 5, "Developing Programs"). When the program is then run, you can use the command line to check or change variable values.

Execution of the program can be resumed in one of two ways.

- Press `Step` (F3 on an external keyboard) to execute next program line.
- Press `Continue` (F2 on an external keyboard) to continue the program until the next `PAUSE`, `STOP` or `END` statement is encountered.

Examining Variables

To examine a variable it is necessary to pause the program. Pausing the program can be accomplished by pressing the `Pause` softkey (F8 on an external keyboard) that is available when a program is running, or by inserting a `PAUSE` statement in your program.

A command line becomes active when an IBASIC program is paused or stopped and an IBASIC display partition is present. (For information on creating an IBASIC display partition, see "Using IBASIC Display" in Chapter 5, "Developing Programs.") You may also activate the command line when no IBASIC window is partitioned by pressing the ESC key on the external keyboard. A cursor will appear in the lower left portion of the screen when the command line is active. Strike the ESC key again to de-activate. Once the command line is active, a variable can be examined in two ways. Both methods require the use of an external keyboard.

1. Enter the variable name (without a line number) on the command line. This results in the value assigned to that variable being shown in the display line of the IBASIC window.
2. Execute the command `PRINT Value` from the command line (where `Value` is the name of the variable being examined). This results in the value assigned to that variable being shown on the print screen of the IBASIC window.

To examine a variable without accessing a command line it is necessary to add the statement `PRINT Value` (or `DISP Value`) to the program before the `PAUSE` statement that temporarily stops the program. `PAUSE`, `PRINT` and `DISP` are all keywords that are included in the IBASIC editor's label window (see Chapter 5, "Developing Programs" for a description of the label window).

Note An IBASIC display partition must be active to view the results of a `PRINT` statement or to access a command line. The display line (accessed with the `DISP` command) is available even when no IBASIC display is present.

Examining Strings

Enter string variables as you would any other variable. Any string variable entered without delimiters will display as much of the string as will fit on the display line of the screen (up to 58 characters).

To select only a section of a string, use the IBASIC substring syntax (see the "HP Instrument BASIC Programming Techniques" section of the *HP Instrument BASIC Users Handbook*). For example, to examine the 7 character substring starting at the second character of A$ enter `A$[2;7]` on the command line or execute the command `PRINT A$[2;7]`.

Examining Arrays

To select an array to be examined you can either select individual elements or the entire array. For example the entry:

```
I_array(1),I_array(2),I_array(3)
```

selects the elements 1 through 3 of the array `I_array` to be displayed.

You may select an entire array to be examined by entering the array variable name and specifying a wildcard (*) for the element (such as `I_array(*)`). If I_array(20) is an integer array, and the first and second elements are set to 100, entering `I_array(*)` would display:

```
100  100  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

Individual array elements (e.g., I_array(17)) can also be specified in the same way as any other single variable.

Displaying the Last Error Encountered

It is sometimes useful to review the last error encountered by a program tbat is being run. This is done from the command line by examining the value assigned to the variable name ERRM$. This value will include the error number and message of the last error encountered by the program.

An additional method of displaying the error message is to use an error trapping subroutine.

For example, insert the following line at the beginning of a program.

```
ON ERROR GOSUB Errormsg
```

The subroutine Errormsg should then be included at the end of the program (after execution is stopped but before the END command).

```
100 Errormsg: !
110   DISP ERRM$
120   PAUSE
130   RETURN
```

The error message is automatically shown on the display line of the IBASIC window and program execution is paused when an error message is encountered.

You may also encounter SCPI errors, in addition to IBASIC errors. SCPI errors can occur when using the OUTPUT command to control the analyzer, when a command syntax is unrecognized or incorrect. For more details on SCPI errors, refer to the *Programmer's Guide*.

7

Graphics and Display Techniques

The analyzer has two measurement channels which can be displayed simultaneously. The instrument's screen can be split into two trace areas for this purpose (upper for channel 1 and lower for channel 2). Additionally, the two measurements can be overlaid onto one full size screen (the default setting). For more information, refer to "Automating Measurements" in the *User's Guide*.

IBASIC programs have the ability to allocate portions of the instrument's display for program output, including text and graphics. This section provides a description of the various programming techniques used to do both. Any of the three measurement display areas, called display partitions, can be used by an IBASIC program. These partitions are shown in Figure 7-1.

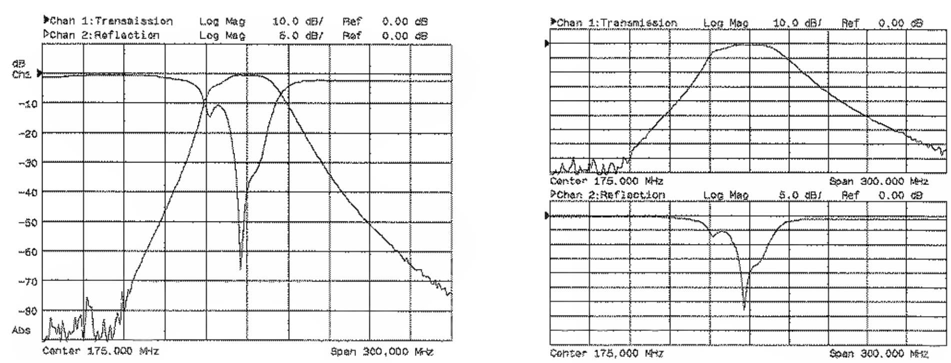


Figure 7-1. Display partitions on the analyzer

Using the Display Partitions

Many IBASIC commands (such as `PRINT`, `DISP`, `CLEAR SCREEN`, `MOVE`, `DRAW` and `GCLEAR`) require a display as an output device. These commands output data to the screen by writing to a screen buffer. Since IBASIC programs share all the hardware resources with the instrument, the display must be shared for instrument and program use.

In order to view this output buffer, a portion of the display must be released from the instrument. When no program is running, you can do this manually, using the (SYSTEM OPTIONS) IBASIC IBASIC Display softkey menu. To do this within a running program requires sending a command to the analyzer both to borrow a part of the display and again to return it for the instrument's use.

This process is called the allocation of display partitions. Manual allocation of display partitions is described in Chapter 5, "Developing Programs." Table 7-1 below includes a summary of the available partitions, their locations and the SCPI mnemonic used to select each partition.

Table 7-1. IBASIC Display Partitions

SOFTKEY	SCPI MNEMONIC	ALLOCATES
None (F1)	DISPlay:PROGram OFF	No Display
Full (F2)	DISPlay:PROGram FULL	The Whole Display
Upper (F3)	DISPlay:PROGram UPPer	Upper Channel Area
Lower (F4)	DISPlay:PROGram LOWer	Lower Channel Area

Allocating Display Partitions

To request a display partition from the analyzer for use by an IBASIC program, send the instrument the corresponding SCPI mnemonic. "DISP:PROG UPPer" allocates the upper partition, "DISP:PROG LOWer" allocates the lower partition, and "DISP:PROG FULL" allocates the full screen partition.

For example, to print a message to the upper partition area, you might use a program segment like this:

```
30  ASSIGN @Hp8711 TO 800
40  OUTPUT @Hp8711;"DISP:PROG UPPer"
50  CLEAR SCREEN
60  PRINT "This is the upper partition"
```

To be sure that you are not writing to a partition that has not yet been assigned, you should include a WAIT statement or, even better, add a SCPI query command followed by an ENTER statement to synchronize the program with the instrument. The previous example might then look like this:

```
30  ASSIGN @Hp8711 TO 800
40  OUTPUT @Hp8711;"DISP:PROG UPPer"
42  OUTPUT @Hp8711;"DISP:PROG?"
44  ENTER @Hp8711;Screen$
46  IF Screen$<>"UPP" THEN GOTO 42
50  CLEAR SCREEN
60  PRINT "This is the upper partition"
```

The mnemonic DISP:PROG? (line 42 above) requests the instrument to send the current partition status. The ENTER statement on the next line reads that status and then continues.

De-Allocating Display Partitions

To return the display partition to the analyzer for use as a measurement screen, use the "DISP:PROG OFF" mnemonic. This should be done before the termination of any program that has allocated a display partition. It may also be required within the program to allow the user to view instrument measurement data. The following example demonstrates this command:

```
830  OUTPUT @Hp8711;"DISP:PROG OFF"
```

Operation with No Display Partition

IBASIC programs can also access the analyzer's display when no partition has been allocated. This can be done through the use of certain areas of the screen. One of these areas is to the right of the measurement display. This area is reserved for softkey labels. It can be accessed using the ON KEY statement.

A second area is a display line (or command line) that appears when no part of the display is allocated for use by IBASIC. This display line, which is located at the lower left corner of the active channel graticule, appears when needed by the INPUT or DISP commands or when activated. To activate the command line, press (ESC) on an external keyboard. Figure 7-2 shows an example of the use of this display line. When the INPUT command is being used, the IBASIC editor's label window and character entry softkey menu appear. Refer to Chapter 5, "Developing Programs," for a description of the IBASIC editor.

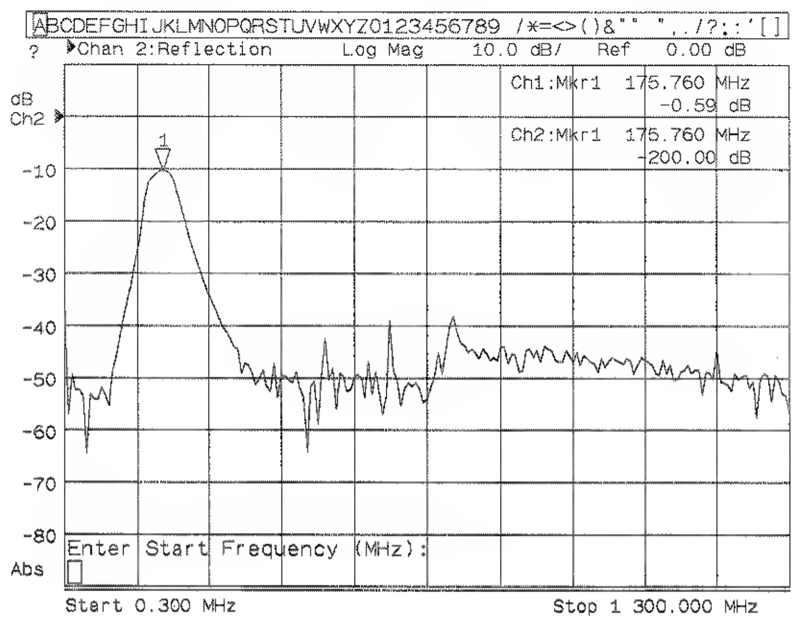


Figure 7-2. Using INPUT with no display partition

In addition to the commands described above, the analyzer has "User Graphics" commands that can write to any of the display partitions. These commands can be used to write to measurement windows as well as the IBASIC window. These commands are described in the "SCPI Graphics Commands" section of this chapter.

Displaying Text

Most of IBASIC's text capabilities are covered in detail in the "HP Instrument BASIC Programming Techniques" section of the *HP Instrument BASIC Users Handbook.* The `PRINT` statement works the same way in every display partition. Information is printed starting at the top left corner of the current partition and continues until the display line of the partition is reached. The screen then scrolls up to allow additional lines to be printed. Figure 7-3 shows the different display partitions and the location of text printed to them. Note that causing the screen to scroll does not affect any graphics displayed on the screen, since text and graphics are written to different planes of the display.

All partitions have a width of 58 characters. The height varies according to partition. Both upper and lower partitions contain 10 lines, while the full partition contains 22 lines.

This information is useful if you are using the `PRINT TABXY` statement to position text. For example, the following program segment prints a message in the center of the full partition (assuming it has been allocated earlier in the program).

```
100  Maxlines=22
110  Tabx=(58-LEN("This is CENTERED text."))/2
120  PRINT TABXY(Tabx,Maxlines/2);"This is CENTERED text."
```

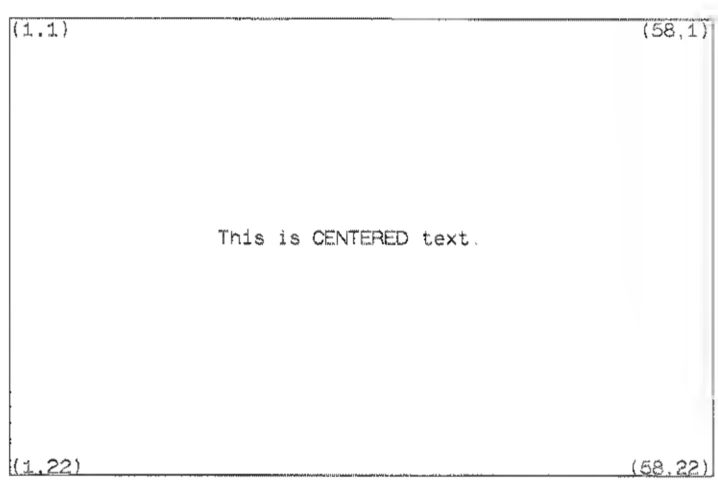


Figure 7-3. Printing to a display partition

A useful technique to get text onto the screen quickly is to write your display message to a long string using the OUTPUT statement, and then print the string to the screen. For large amounts of text, this speeds up screen display time considerably. The following program segment demonstrates this:

```
60   DIM Temp$[100],Big$[2000]
70   OUTPUT Temp$;"This is the first line of text"
80   Big$=Big$&Temp$
90   OUTPUT Temp$;"This is the second line of text"
100  Big$=Big$&Temp$
110  PRINTER IS CRT; WIDTH 2000
120  PRINT Big$
```

The OUTPUT statements in this example are used to copy each line of the message into the variable Temp$ and append a carriage return.

You can also print to the screen using the OUTPUT statement in conjunction with the display address (1). For example, line 150 below writes a string to the screen.

```
150  OUTPUT CRT;"OUTPUT 1 WORKS WELL TOO"
```

Pop-up Message Windows and Custom Annotations

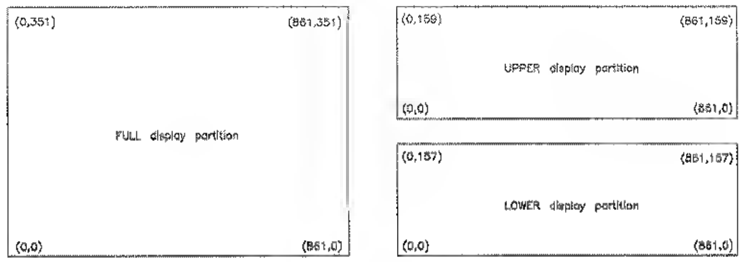
From your IBASIC program, you can replace instrument annotations with user-defined annotations. You can change the X-axis labels and channel annotations to customize the display. Pop-up messages may also be used to display permanent or temporary messages. Refer to "Automating Measurements" in the *User's Guide*.

Graphics Initialization and Scaling

In all partitions, display coordinate 0,0 is at the bottom left corner and clipping occurs automatically if the X,Y coordinate exceeds the displayable range of the current partition. Figure 7-4 shows the different partitions and the pixel dimensions (GESCAPE values) for each.

After a GINIT command, the display is dimensioned as 100 GDU's (Graphical Display Units) high and 245 GDU's wide (assuming full partition). This gives a RATIO result of 2.45 and provides the same results as issuing a WINDOW 0,245,0,100 command. In order to prevent circles from appearing oval shape, this ratio should be maintained. You can also issue a WINDOW 0,861,0,351 command. This will maintain the same ratio but the display will now be dimensioned in actual pixel unit. This may be more useful than the default GINIT values since fractional display units are not needed, allowing integers only to be used; thus speeding execution. These are also the same values that are returned by utilizing the GESCAPE command (see BARCODE program example). The GESCAPE command will always set the current pixel dimension sizes. Because the results of this command can vary drastically with partition size, you must first partition the display BEFORE executing the GINIT and GESCAPE commands.

Note Upon power up, the default display coordinates are 0,861,0,351 and will remain that until a GINIT is performed. It is recommended that a GINIT command always be part of any graphics program and that it be executed only after the display partition is set.



pd83a

Figure 7-4. Pixel Dimensions with Available Display Partitions

Using Graphics

IBASIC's graphics commands are easy to understand and use. You can use the `MOVE` statement to move the "pen" to a specific pixel location (without drawing) and then draw a line from the current pen location to another pixel coordinate using the `DRAW` statement. The `GCLEAR` statement removes all graphics.

The `PEN` command provides an easy method of erasing lines drawn by the `DRAW` command. When `PEN 1` is issued (the default state), all `DRAW` commands act normally, drawing a line with the full intensity. When `PEN 0` is issued, all `DRAW` commands erase any pixels their path encounters. Where there are no lines in the path, no change is visible. As an example of using the `MOVE` and `DRAW` commands, the following statement moves the logical pen to a point 100 units to the right of, and 150 units above, the lower left corner of the display:

```
100  MOVE 100,150
```

This statement then draws a line to coordinates (200,10):

```
110  DRAW 200,10
```

Finally, these two statements erase the previously drawn line:

```
120  PEN 0
130  DRAW 100,150
```

Although text and graphics appear together, you can clear them separately. Use `CLEAR SCREEN` to clear the text. Use `GCLEAR` to clear the graphics.

Drawing Figures

Some IBASIC keywords listed below may be used to simplify drawings and setup diagrams. See also, the paragraph below titled "Graphics Exceptions".

POLYGON - Draws all or part of a regular polygon

RECTANGLE - Draws a rectangle

LABEL - Produces alphanumeric labels

CSIZE - Sets size and aspect ratio of labels

LDIR - Defines the angle at which a label is to be drawn

LORG - Defines the relative origin of a label

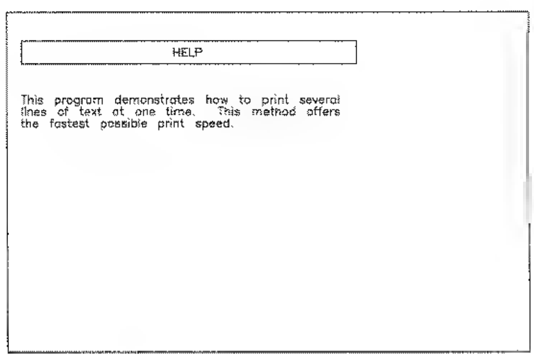
These keywords are used in the "BARCODE" program example listed in Chapter 11, "Example Programs", and on the IBASIC Example Programs Disk. The keywords appear in the subprograms 'Box', 'Circle', and 'Label' described below.

```
1620 ! Draw a box in the active IBASIC partition
1621 ! Xpos,Ypos specify the CENTER of the box
1622 ! Xsize,Ysize are width and height dimensions
1623 ! Sc is a scaling factor for the figure being drawn
1624 ! 1.79 is a correction factor used by the 8711 only
1630 Box:SUB Box(Xpos,Ypos,Xsize,Ysize)
1640   COM /Scale/ Sc,INTEGER X,Y
1650   MOVE X+(Xpos-Xsize/2)*Sc,Y+(Ypos-Ysize/2)*Sc
1660   RECTANGLE Xsize*Sc,Ysize*Sc*1.79 !8711 Pixel H:W Ratio
1670  SUBEND

1681 ! Draw a circle in the active IBASIC partition
1682 ! Xpos,Ypos specify the center of the circle
1683 ! Radius is the size of the circle
1684 ! Sc is a scaling factor for the figure being drawn
1690 Circle:SUB Circle(Xpos,Ypos,Radius)
1700  COM /Scale/ Sc,INTEGER X,Y
1710  MOVE X+Xpos*Sc,Y+Ypos*Sc
1720  POLYGON Radius*Sc,16,16
1730  SUBEND

1890 ! Creates a label in the active IBASIC partition
1891 ! Text$ is the alphanumeric label
1892 ! Xpos,Ypos is the position of the label
1893 ! Lorg references the label oriontation to Xpos,Ypos
1894 ! Ldr is the angle in which the label will be drawn
1895 ! Pen is pen number (0 erases)
1896 ! Sc is a scaling factor for the figure being drawn
1900 Label:SUB Label(Text$,Xpos,Ypos,Size,Lorg,Ldr,Pen)
1910    COM /Scale/ Sc,INTEGER X,Y
1920    LORG Lorg
1930    LDIR Ldr
1940    CSIZE Size*Sc,1
1950    MOVE X+Xpos*Sc,Y+Ypos*Sc
1960    PEN Pen
```

```
1970    LABEL Text$
1980    PEN 1
1990 SUBEND
2000 !
```

The following program displays a "HELP" screen and demonstrates many of the techniques discussed so far. Running this program produces the screen display shown in Figure 7-5.

```
10   DIM A$[58],String$[1000]
20   ASSIGN @Hp8711 TO 800
30   OUTPUT @Hp8711;"DISP:PROG FULL;*WAI"
40   GINIT
50   GCLEAR
60   MOVE 0,89
70   RECTANGLE 200,14
80   PRINT TABXY(24,2);"HELP"
90   OUTPUT A$;"This program demonstrates how to print several"
100  String$=String$&A$
110  OUTPUT A$;"lines of text at one time.  This method offers"
120  String$=String$&A$
130  OUTPUT A$;"the fastest possible print speed."
140  String$=String$&A$
150  PRINTER IS CRT;WIDTH 1000  ! Prevent auto cr/lf
160  PRINT TABXY(1,5);String$
170  END
```



pd62o

Figure 7-5. "HELP" program output

Graphics Exceptions

The following graphics commands do not conform to the keyword description found in the *HP Instrument BASIC Users Handbook*:

VIEWPORT - Does not create isotropic units that are physically square. Does not soft clip the display area.

CLIP - The analyzer does not support graphics clipping.

SHOW - Does not create isotropic units.

POLYLINE, POLYGON, RECTANGLE, RPLOT - The analyzer does not support the FILL or EDGE options. Also see next paragraph.

GRID, RECTANGLE, POLYGON, and POLYLINE scaling differences

When the display is initialized using GINIT, the display will be scaled to a height of 100 GDU's and a width of 245 GDU's.

The ratio is 2.453 and the pixel height-to-width ratio is fixed at 1.79 (non square pixels). This can cause scaling difficulties if not well understood, and will produce different results than is seen on HP BASIC computers or workstations. The following examples should help clarify some scaling issues.

After GINIT, performing a GRID 10,10 command will produce a grid array 10 high and 24.5 wide. The individual grids will be rectangular (taller than wide). To produce square grids, perform a GRID 10*1.79,10 command. This will produce square grids; 10 high and just under 14 wide. If you move the starting point to approximate center (MOVE 120,50) and request a square 55 wide by 55 high (RECTANGLE 55,55), the analyzer will automatically scale this so as to appear square. The width will be 55 GDU's but the height will be 55/1.79 or 30.7 units high. This will appear square and is quite a different result than would be obtained by attempting to plot a "square" 55 units on each side; this would instead, produce a rectangle.

A similar scaling is done with the POLYGON command. If a POLYGON 80 command is given, the analyzer will produce a circle with a horizontal radius of 80, but with a vertical radius of 44.7 GDU's; even so, it will appear circular.

The following is a simple rule to remember with GINIT values (or the equivalent WINDOW ratio) on the analyzer: The analyzer will produce circles with the POLYGON/POLYLINE command and squares with the RECTANGLE command (assuming equal x,y) in all cases. However, the radius or width (in GDU's) will be accurate only in the horizontal axis and will be 1.79 times LESS in the vertical axis.

Try this simple program to demonstrate the above examples. Un-comment line 60 and comment out line 50 to show the difference in the two GRID statements. The rectangle may be hard to see since it will partially lie on a gridline; its lower left corner is at the centered dot.

```
10   ASSIGN @Hp8711 TO 800
20   OUTPUT @Hp8711;"DISP:PROG FULL"
30   GINIT
40   GCLEAR
50   GRID 10,10      ! makes rectangular grids
60   ! GRID 10*1.79,10 ! makes square grids
```

```
70   MOVE 120,50      ! move to center
80   POLYGON 1       ! make small dot
90   RECTANGLE 55,55   ! makes square
100   POLYGON 80
110   END
```

Labeling with Different Partitions

The LABEL command may be used to label graphs, however, the following should be noted. Labels that may be of the correct size for a full screen partition will appear half as big if a GINIT is performed after the analyzer has been set to either the upper or lower half partition. This is because the CSIZE command scales according to display height, not width. Since the display height is one-half, the character size will also be one-half. Labels that are scaled properly for full screen displays will not be scaled properly for half screen displays and vice-versa.

SCPI Graphics Commands

In addition to the commands described earlier in this chapter, there are several SCPI mnemonics that can be used to create graphics and messages on the display of the analyzer.

These commands are instrument specific mnemonics, not standard IBASIC commands. They are also different from the previously described IBASIC commands in that they do not require an IBASIC display partition. This means that they can be used to write or draw directly to a measurement window.

These commands, listed in Table 7-2 are SCPI mnemonics and are programmable from an external controller as well as from IBASIC. The commands are of the form

`DISPlay:WINDow[1|2|10]:GRAPhics:<command>.`

The number specified in the `WINDow` part of the command selects where the graphics are to be written.

`WINDow1` draws the graphics to the channel 1 measurement window.
`WINDow2` draws the graphics to the channel 2 measurement window.
`WINDow10` draws the graphics to an IBASIC display partition.

Tip When SCPI graphics commands are used to write directly to a measurement window they write to the static graphics plane (the same plane where the graticule is drawn). There is no sweep-to-sweep speed penalty once the graphics have been drawn.

Table 7-2. SCPI Graphics Commands

SCPI COMMAND	FORM	DESCRIPTION
DISPlay:WINDow[1|2|10]:GRAPhics :CIRCle <radius>	command only	Draw a circle of the specified Y-axis radius centered at the current pen location — radius is in pixels.
DISPlay:WINDow[1|2|10]:GRAPhics :CLEar	command only	Clear the user graphics and graphics buffer for the specified window.
DISPlay:WINDow[1|2|10]:GRAPhics :COLor <num>	NR1	Set the color of the user graphics pen — choose from 0 for erase, 1 for bright, and 2 for dim.
DISPlay:WINDow[1|2|10]:GRAPhics [:DRAW] <x>,<y>	command only	Draw a line from the current pen position to the specified new pen position — x and y are the new absolute X and Y coordinates in pixels.
DISPlay:WINDow[1|2|10]:GRAPhics :LABel <string>	command only	Draw a label with the lower left corner at the current pen location.
DISPlay:WINDow[1|2|10]:GRAPhics :LABel:FONT <font>	CHAR	Select the user graphics label font — choose from SMALl|HSMall|NORMal|BNORmal|BOLD|BBOLd|SLANt|BSLant.
DISPlay:WINDow[1|2|10]:GRAPhics :MOVE <x>,<y>	NR1,NR1	Move the pen to the specified new pen position — x and y are the new absolute X and Y coordinates in pixels.
DISPlay:WINDow[1|2|10]:GRAPhics :RECTangle <xsize>,<ysize>	command only	Draw a rectangle of the specified size with lower left corner at the current pen position — xsize and ysize are the width and height in pixels.

For more information about the analyzer's user graphics commands, refer to Chapter 7 of the *Programmer's Guide*. Refer also to the example program titled "GRAPHICS" in Chapter 11 of the Programmer's Guide.

8

Interfacing with External Devices

This section describes the techniques necessary for programming the HP-IB interface. It describes how this interface works and how to use it to control or interface with systems containing various HP-IB devices. It also describes how to interface with external devices using the serial and parallel interfaces.

The HP-IB interface is Hewlett-Packard's implementation of the IEEE-488.1 Digital Interface for Programmable Instrumentation. The acronym HP-IB stands for "Hewlett-Packard Interface Bus," and is often referred to as the "bus." The interface is easy to use and allows great flexibility in communicating data and control information between an HP Instrument BASIC program and external devices.

IBASIC is an HP-IB instrument controller residing inside an instrument. It uses the instrument's HP-IB interface for external communication and an internal HP-IB interface to communicate with the instrument. This unique arrangement presents a few differences between IBASIC's implementation of HP-IB control and HP BASIC controllers. A description of the interaction of IBASIC with the host instrument and the external HP-IB interface is given in the section entitled "The IBASIC HP-IB Model", later in this chapter.

Communication with Devices

HP-IB Device Selectors

Since the HP-IB allows several devices to be interconnected, each device must be uniquely identified. Specifying the select code of the HP-IB interface (such as 7 or 8) to which a device is connected is not enough to uniquely identify each specific device on the bus.

Each device on the bus has a primary address that identifies it. This address can be set by the user. It must be unique to allow individual access of each device. When a particular HP-IB device is to be accessed, it must be identified with both its interface select code and its bus address.

The interface select code is the first part of an HP-IB device selector. IBASIC programs run inside an instrument and communicate with it over an internal bus (interface select code 8). IBASIC programs can also communicate with external devices using the instrument's HP-IB interface (select code 7).

The second part of an HP-IB device selector is the device's primary address, an integer in the range of 0 through 30. For example, to specify the device on the interface at select code 7 with a primary address of 22, use device selector 722. Secondary HP-IB addressing is

also supported for those devices requiring it. These devices will have at least 5-digit service selection such as 72201.

Since the analyzer is the only device on the internal interface, its primary address on that interface is arbitrary and the instrument will respond to any primary address with a select code equal to 8 (e.g., 800, 811, 822, etc.).

Note Each device's address must be unique. The analyzer is shipped from the factory with a primary address of 16. No other device on the bus should use the same address.

The procedure for setting the address of an HP-IB device is given in the installation manual for each device. To set the address of the analyzer, use the softkeys in the (SYSTEM OPTIONS) HP-IB menu, or the SCPI mnemonic SYST:COMM:GPIB:ADDR.

Moving Data Through the HP-IB

Data is output and entered into the program through the HP-IB with the OUTPUT and ENTER statements, respectively. The only difference between the OUTPUT and ENTER statements for the HP-IB and those for other interfaces is the addressing information within HP-IB device selectors.

The following examples show several different syntax styles which you can use.

```
100  Hpib=7
110  Device_addr=22
120  Device_selector=Hpib * 100 + Device_addr
130   !
140  OUTPUT Device_selector;"F1R7T2T3"
150  ENTER Device_selector;Reading

320  ASSIGN @Hpib_device TO 702
330  OUTPUT @Hpib_device;"Data message"
340  ENTER @Hpib_device;Number

440  OUTPUT 800;"SOUR1:POW -10 dBm"

480  ENTER 724;Readings(*)
```

General Structure of the HP-IB

Communications through the HP-IB are made according to a precisely defined standard (the IEEE 488.1 standard). The rules set by IEEE 488.1 ensure that orderly communication takes place on the bus. For more information about the structure of the HP-IB and the IEEE 488.1 standard, refer to the *Tutorial Description of the Hewlett-Packard Interface Bus*.

Devices that communicate over the HP-IB perform one or more of the following three functions.

- Talk — send data over the bus
- Listen — receive data over the bus
- Control — control the exchange of data on the bus

The System Controller

The controller is a device that has been designated to control the communication occurring on the bus. It specifies which device talks, which device listens and when the exchange of data takes place.

An HP-IB system can have more than one device with the ability to control the bus, but only one of these devices is allowed to control the exchange of data at any given time. The device that is currently controlling the exchange of data is called the **Active Controller**.

One device must be able to take control of the bus even if it is not the active controller. The device designated as the **System Controller** is the only device with this ability. To designate the analyzer as the system controller use the `System Controller` softkey in the (SYSTEM OPTIONS) `HP-IB` menu.

The system controller is generally designated before running a program and should not be changed under program control. An exception to this is when an IBASIC program is running on the analyzer's internal controller. If the IBASIC program controls other HP-IB devices, the analyzer must be designated as the system controller.

A SCPI mnemonic `SYST:COMM:GPIB:CONT <ON|OFF>` can be used to make the analyzer the system controller. Program execution should be carefully synchronized, using the Operation Complete command (`*OPC?`) and waiting for a reply before any `OUTPUT 7xx` command is sent. (Refer to the "Synchronizing the Analyzer and a Controller" chapter in the *Programmer's Guide* for more information on the `*OPC?` command.)

Using the Serial and Parallel Ports

The analyzer has two additional ports that can be used to control peripherals, material handlers or other devices. Active control of the HP-IB interface is not needed when these ports are being used. These ports are a parallel port and a serial port for use with hardcopy output to non-HP-IB printers and plotters.

In addition to the serial and parallel ports, there are also two BNC connectors on the rear panel of the analyzer. These connectors provide access (using TTL signal levels) to two programmable bits.

- Limit Test TTL bit — indicates the results of a pass/fail limit test
- User TTL bit — to be used as needed (for example to use with a foot pedal)

Using the Analyzer Ports in IBASIC programs

IBASIC can directly control the serial port, the parallel port, the Pass/Fail TTL bit, and the User bit without using HP-IB commands with `READIO` and `WRITEIO`. `READIO` and `WRITEIO` are faster than HP-IB commands.

Writeable Ports

`WRITEIO`	`15,0;A`	Outputs 8-bit data to the Cent_D0 through D7 lines of the Centronics port. Cent_D0 is the least significant bit, Cent_D7 is the most significant bit. Sets Printer_select signal high (de-select). Checks Centronics status lines for • Out of Paper • Printer Not on Line • BUSY • ACKNOWLEDGE
`WRITEIO`	`15,1;A`	Sets/clears the "user" bit according to the least significant bit of A. A least significant bit equal to 1 sets the user bit high. A least significant bit of 0 clears the user bit.
`WRITEIO`	`15,2;A`	Sets/clears the limit pass/fail bit according to the least significant bit of A. A least significant bit equal to 1 sets the pass/fail bit high. A least significant bit of 0 clears the pass/fail bit.
`WRITEIO`	`15,3;A`	Outputs 8-bit data to the Cent_D0 through D7 lines of the Centronics port. Cent_D0 is the least significant bit, Cent_D7 is the most significant bit. Sets Printer_select signal high (de-select). Does not check Centronics status lines.
`WRITEIO`	`9,0;A`	Outputs a byte to the serial port. The byte is output serially according to the configuration for the serial port. (See above.)

Readable Ports [`I=READIO(A,B)`]

`READIO`	`9,0`	Reads the serial port.
`READIO`	`15,0`	Reads the 8-bit data port, Cent_D0 through D7.
`READIO`	`15,1`	Reads the user bit.
`READIO`	`15,2`	Reads the limit test pass/fail bit.
`READIO`	`15,10`	Reads the 8-bit status port • D0 – Cent_acknowledge • D1 – Cent_busy • D2 – Cent_out_of_paper • D3 – Cent_on_line • D4 – Cent_printer_err

An example program, `REPORT`, demonstrating peripheral control over the parallel port is provided in Chapter 11, "Example Programs."

Refer to "Automating Measurements" in the *Users Guide* for further explanation and examples of how to access the analyzer's I/O ports.

General Bus Management

The HP-IB standard provides several mechanisms that allow managing the bus and the devices on the bus. Here is a summary of the IBASIC statements that use these control mechanisms.

`ABORT` — abruptly terminates all bus activity and resets all devices to their power-on HP-IB states.

`CLEAR` — sets selected (or all) devices to a pre-defined, device-dependent HP-IB state.

`LOCAL` — returns selected (or all) devices to local (front panel) control.

`LOCAL LOCKOUT` — disables selected (or all) devices' front panel controls.

`REMOTE` — puts selected (or all) devices into their device-dependent, remote modes.

`SPOLL` — performs a serial poll of the specified device (which must be capable of responding).

`TRIGGER` — sends the trigger message to a device (or selected group of devices).

These statements (and functions) are described in the following discussion. However, the actions that a device takes upon receiving each of the above commands are, in general, different for each device. For external devices, refer to the particular device's manuals to determine how it will respond.

All of the bus management commands, with the exception of `ABORT`, require that the program be the active controller on the interface. A running IBASIC program is always active controller on the internal interface (select code 8). For the program to be active controller on the external interface (select code 7), the instrument must either be set as system controller or have control passed to it from an external controller. The program automatically assumes the controller status of the host instrument. For more information refer to "The IBASIC HP-IB Model" section later in this chapter.

Note In this section the term **Host Instrument** refers to the instrument where the IBASIC controller is located.

REMOTE

Most HP-IB devices can be controlled either from the front panel or from the bus. If the device's front panel controls are currently functional, it is in the Local state. If it is being controlled through the HP-IB, it is in the Remote state. Unless operating in the Local Lockout mode, each HP-IB device has method (usually a key) to return itself to Local (front panel) control.

When the analyzer is being controlled by a program running on an external controller, the `Return to Local` softkey is always available to return the analyzer to Local control.

The Remote message is automatically sent to all devices whenever the system controller is powered on, reset, or sends the Abort message. A device also enters the Remote state automatically whenever it is addressed. The `REMOTE` statement also outputs the Remote message, which causes all (or specified) devices on the bus to change from local control to remote control. The host instrument must be designated as the system controller before an IBASIC program can execute the `REMOTE` statement on select code 7.

Host Instrument

The `REMOTE` statement has no effect on the host instrument since it is always in remote control whenever an IBASIC program is running. Specifying the internal interface in a `REMOTE` statement will not generate an error, but will have no effect.

LOCAL LOCKOUT

The Local Lockout message effectively locks out the "local" switch present on most HP-IB device front panels. It maintains system integrity by preventing a user from interfering with system operations by pressing buttons. As long as Local Lockout is in effect, no bus device can be returned to local control from its front panel.

The Local Lockout message is sent by executing the `LOCAL LOCKOUT` statement. This message can be sent to all devices on the external interface by specifying the bus address (7). Specifying a single address on the bus (i.e. 722) sends the command to only the device at that address. The Local Lockout message is cleared when the Local message is sent by executing the `LOCAL` statement. However, executing the `ABORT` statement does not cancel the Local Lockout message.

Host Instrument

The Local Lockout message is not supported for the host instrument since front panel control is always necessary in order to pause or abort the program. Specifying the internal interface in a `LOCAL LOCKOUT` statement will not generate an error, but will have no effect.

LOCAL

During system operation, it may be necessary for an operator to interact with one or more external devices. For instance, an operator might need to work from the front panel to make special tests or to troubleshoot. It is also good systems practice to return all devices to local control when remote-control operations are complete. Executing the `LOCAL` statement returns the specified devices to local (front panel) control.

If primary addressing is specified, the Go-to-Local message is sent only to the specified device(s). However, if only the interface select code is specified (`LOCAL 7`), the Local message is sent to all devices on the external interface and any previous Local Lockout message (which is still in effect) is automatically cleared.

Host Instrument

The `LOCAL` statement has no effect on the host instrument since it is always in remote control whenever an IBASIC program is running. Specifying the internal interface in a `LOCAL` statement will not generate an error.

TRIGGER

The `TRIGGER` statement sends a Trigger message to a selected device or group of devices. The purpose of the Trigger message is to initiate some device-dependent action; for example, it can be used to trigger a digital voltmeter to perform its measurement cycle. Because the response of a device to a Trigger message is strictly device-dependent, neither the Trigger message nor the interface indicates what action is initiated by the device.

Specifying only the interface select code outputs a Trigger message to all devices currently addressed to listen on the bus. Including a device address in the statement triggers only the device addressed by the statement.

Host Instrument

The `TRIGGER` statement is supported by the analyzer. Issuing a `TRIGGER` command will initiate a single sweep assuming the analyzer is in `TRIGGER` hold mode. `TRIGGER` is ignored if not in hold mode.

CLEAR

The `CLEAR` statement provides a means of "initializing" a device to its predefined device-dependent state. When the `CLEAR` statement is executed, the Clear message is sent either to all devices or to the specified device, depending on the information contained within the device selector. If only the interface select code is specified, all devices on the specified HP-IB interface are cleared. If primary-address information is specified, the Clear message is sent only to the specified device. Only the active controller can send the Clear message.

Host Instrument

The `CLEAR` statement is fully compatible on the internal interface.

ABORT

This statement may he used to terminate all activity on the external bus and return the HP-IB interfaces of all devices to reset (or power-on) condition. Whether this affects other modes of the device depends on the device itself. The IBASIC program must be either the active or the system controller to perform this function. If it is the system controller and has passed active control to another device, executing this statement causes active control to be returned. Only the interface select code may be specified; primary-addressing information (such as 724) must not be included.

Aborting the Internal Bus

`ABORT` is not supported for select code 8. Executing `ABORT 8` will not generate an error.

HP-IB Service Requests

Most HP-IB devices, such as voltmeters, frequency counters, and network analyzers, are capable of generating a "service request" when they require the active controller to take action. Service requests are generally made after the device has completed a task (such as making a measurement) or when an error condition exists (such as a printer being out of paper). The operating and/or programming manuals for each device describe the device's capability to request service and conditions under which the device will request service. To request service, the device sends a Service Request message (SRQ) to the active controller. The mechanism by which the active controller detects these requests is the SRQ interrupt. Interrupts allow an efficient use of system resources, because the system may be executing a program until interrupted by an event's occurrence. If enabled, the external event initiates a program branch to a routine which "services" the event (executes remedial action).

Setting Up and Enabling SRQ Interrupts

In order for an HP-IB device to be able to initiate a service routine in the active controller, two prerequisites must be met: the SRQ interrupt event must have a service routine defined, and the SRQ interrupt must be enabled to initiate the branch to the service routine.

The following program segment shows an example of setting up and enabling an SRQ interrupt.

```
100  Hpib=7
110  ON INTR Hpib GOSUB Service_routine
120   !
130  Mask=2
140  ENABLE INTR Hpib;Mask
```

Since IBASIC recognizes only SRQ interrupts, the value assigned to the mask is meaningless. However, a mask value may be present as a placeholder for compatibility with HP Series BASIC programs.

When an SRQ interrupt is generated by any device on the bus, the program branches to the service routine when the current line is exited (either when the line's execution is finished or when the line is exited by a call to a user-defined function). The service routine, in general, must perform the following operations:

1. Determine which device(s) are requesting service
2. Determine what action is requested
3. Clear the SRQ line
4. Perform the requested action
5. Re-enable interrupts
6. Return to the former task (if applicable)

Note The `ON INTR` statement must always precede the `ENABLE INTR` statement when the two are used in the same program.

Servicing SRQ Interrupts

The SRQ is a level-sensitive interrupt; in other words, if an SRQ is present momentarily but does not remain long enough to be sensed by the controller, an interrupt will not be generated. The level-sensitive nature of the SRQ line also has further implications, which are described in the following paragraphs.

Example

Assume that only one device is currently on the bus. The following service routine serially polls the device requesting service and clears the interrupt request. In this case, the controller does not have to determine which device was requesting service because only one device is present. Since only service request interrupts are enabled in IBASIC, the type of interrupt does not need to be determined either. The service is performed, and the SRQ event is re-enabled to generate subsequent interrupts.

```
500 Serv_rtn:  Ser_poll=SPOLL(@Device)
510  ENTER @Device;Value
520  PRINT Value
530  ENABLE INTR 7   ! Use previous mask.
540  RETURN
```

The IEEE standard states that when an interrupting device is serially polled, it is to stop interrupting until a new condition occurs (or the same condition occurs again). To "clear" the SRQ line, a serial poll must be performed on the device. By performing this serial poll, the controller acknowledges to the device that it has seen the request for service and is responding. The device then removes its request for service (by releasing SRQ).

If the SRQ line had not been released, the controller would have branched to the service routine immediately upon re-enabling interrupts on this interface. This is due to the level-sensitive nature of the SRQ interrupt.

Also note that once an interrupt is sensed and logged, the interface cannot generate another interrupt until the first interrupt is serviced. The controller disables all subsequent interrupts from an interface until a pending interrupt is serviced.

Conducting a Serial Poll

A sequential poll of individual devices on the bus is known as a Serial Poll. A byte of device-specific status is returned in response to a Serial Poll. This byte is called the "Status Byte" message and, depending on the device, may indicate an overload, a request for service, or a printer being out of paper. The particular response of each device depends on the device.

The SPOLL function performs a Serial Poll of the specified device; the program must currently be the active controller in order to execute this function.

Examples

```
ASSIGN @Device TO 700
Status_byte=SPOLL(@Device)

Spoll_724=SPOLL(724)
```

The Serial Poll is meaningless for an interface since it must poll individual devices on the interface. Therefore, primary addressing must be used with the SPOLL function.

Passing and Regaining Control

Active control of the bus can be passed between controllers using the PASS CONTROL command. The following statements first define the HP-IB interface's select code and the new active controller's primary address and then pass control to that controller.

```
100  Hp_ib=7
110  New_ac_addr=20
120  PASS CONTROL 100*Hp_ib+New_ac_addr
```

Once the new active controller has accepted active control, the controller passing control assumes the role of a non-active controller on the specified HP-IB interface. The concept of using pass control with IBASIC is discussed in the next section, "The IBASIC HP-IB Model."

The IBASIC HP-IB Model

The fact that IBASIC resides in, and coexists with an instrument poses a large set of possible interactions, both internal to the instrument and externally with other controllers and instruments. This section defines the principal players and rules of order when IBASIC is running within the host instrument.

External and Internal Busses

There is physically only one HP-IB port and one HP-IB address for the analyzer. IBASIC has access to two HP-IB ports: the "real" external port (select code 7) and a "virtual" internal port (select code 8), through which it communicates with the analyzer.

The analyzer has only one output buffer, one input buffer and one set of status registers. Commands and data from both ports are placed in the same input buffer and data read out of both ports comes from the same output buffer. The instrument will not provide any kind of arbitration between an external controller and an IBASIC program.

The analyzer always behaves as if there is only one controller. If an IBASIC program is running, it is assumed to be the controller and therefore will receive all SRQs from the host instrument (via the internal port).

Service Request Indicators

An external controller may perform a serial poll (`SPOLL`) at any time without affecting a running IBASIC program. There are two Service Request Indicators (SRI) - one for the external port and one for the internal port. The internal SRI can only be cleared by an IBASIC program performing an `SPOLL` on device 800. The external SRI can only be cleared by an `SPOLL` from an external controller and can only be set when there is not an active IBASIC program.

The two SRI's will be set to their OR'd value when a program starts, and again when it finishes. This assures that any pending SRQ's can be serviced by the instrument's new controller.

The pausing or termination of a program will cause the Program Running bit in the Device Status register to go low. This can be used to generate an external SRQ. (For an example, see the **DUALCTLR** example in Chapter 11, "Example Programs.")

IBASIC as the Active Controller

The IBASIC program is always the active controller on the internal interface (select code 8). When a program starts running, the HP-IB controller status of the instrument is automatically passed to the program. For example, if the instrument is set as System Controller, a program running in the instrument automatically becomes system controller and active controller on the external bus and the instrument relinquishes active control. When the program stops, the instrument regains active control.

Also, if an instrument set as Talker/Listener is passed control from an external controller, any program running in the instrument becomes active controller on the external interface.

Thus, there are two cases where a program running in an instrument can be active controller on the external interface:

- When the host instrument is set as System Controller and the program has not passed control
- When the host instrument is set as Talker/Listener and the instrument has been passed control from an external controller.

Passing Active Control to the Instrument

The only way that the analyzer can gain active control of the external interface while a program is running is if the program is currently the active controller on select code 7 and passes control to the instrument. Normally, the active controller on the 7 bus can pass control to any device on the interface by using the statement

```
PASS CONTROL 7xx
```

where "xx" represents the address of the device on the bus. Because an IBASIC program does not interface with the host instrument over select code 7, a different method is used to pass control in this case. To pass active control of the external interface from an IBASIC program to the host instrument, use the statement

```
PASS CONTROL 8xx
```

where “xx” represents any two digit number from 00 to 99. This allows the instrument to control external plotters, printers and disk drives. When the instrument is finished with its HP-IB control activity, it automatically passes control back to the program.

Note Control over the internal bus is used to govern access to the external bus. When the instrument is given control over the internal bus, it is actually given access to the external HP-IB hardware.

IBASIC as a Non-Active Controller

IBASIC programs are always the active controller on the internal interface. There are two cases where an IBASIC program does not have control of the external HP-IB interface:

- When the host instrument is set as Talker/Listener and active control has **NOT** been passed from an external device
- When the host instrument is set as System Controller and the program has passed control to either the host instrument or another device on the external interface

In both of these cases, the program cannot perform activities of any kind on the external interface.

Note An IBASIC program cannot act as a device on the external bus. To communicate with an external controller, the IBASIC program must be active controller and the external controller must act as the device (see the "Interfacing with an External Controller" section that follows).

Interfacing with an External Controller

So far, we have discussed the ability to interface IBASIC programs with a network of external devices using the HP-IB. The idea of including an external controller in that network, and interfacing an IBASIC program with a program running in that computer presents some new possibilities.

External controller programs can interface with IBASIC programs (referred to as "internal programs") over HP-IB in two basic ways:

First, the two programs can pass data back and forth using simple `OUTPUT` and `ENTER` statements. This requires coordination of both the internal and external programs and also requires that the internal program be the active controller during the interaction. To get an internal program and an external program to work together successfully, you should have a good understanding of the HP-IB model, presented earlier in this chapter.

Second, the external program can make use of the extensive set of analyzer HP-IB commands that interface with IBASIC programs. These mnemonics fall under the subsystem `PROGram` and allow the external controller to remotely perform many of the IBASIC front panel activities. This includes the ability to run, stop, pause, continue and delete an internal program. You can also remotely query or set the values of numeric and string variables.

Also included in the analyzer HP-IB command set are commands that allow you to transfer programs and program data to and from the instrument. Programs can be transferred (uploaded and downloaded) between an external controller and the program buffer in the instrument, and data can be transferred between an external program and a non-running internal program by setting and querying internal program variables. These SCPI mnemonics are described in the *Programmer's Guide*.

Also, refer to example programs included on the *IBASIC Example Programs Disk*: `DUALCTRL`, `TRICTRL`, `UPLOAD` and `DOWNLOAD`. These programs demonstrate using IBASIC with an external controller.

Synchronizing IBASIC with an External Controller

Using OUTPUT and ENTER statements

Commands sent to the analyzer with OUTPUT and ENTER statements from IBASIC and from the external controller at the same time must be synchronized by the programmer. These commands cannot be allowed to overlap. Overlapped commands sent from the external controller and IBASIC will result in unpredictable behavior or deadlocks.

For example:

If the external controller executes:

```
OUTPUT 716;“<command>”
```

and IBASIC simultaneously executes:

```
OUTPUT 800;“<command>”
```

the results are unpredictable.

To avoid overlapped commands, you must ensure that only the controller is allowed to send commands or only IBASIC is allowed to send commands at any one time. One possible method to avoid overlap is described below. For this method, when the respective controller is done sending commands, the other controller is informed. The alternate controller then may begin sending commands. After each set of commands is completed, the alternate controller is informed and given a signal to send commands to the analyzer. See example program TRICTRL in Chapter 11.

Using Status information

Status information must also be synchronized between the IBASIC program and a program running on an external controller. The status information is shared between these programs. Commands which affect the status information should not overlap between the IBASIC program and the external controller.

For example:

From an external controller:

```
OUTPUT 716;"< command >;*OPC?"
ENTER 716;Opc
```

From IBASIC, simultaneously execute:

```
OUTPUT 800;"*CLS"
```

may cause the external controller to not complete execution. The *CLS command clears status information which the external controller may be waiting for. The commands which affect status information include *OPC, *OPC?, *WAI, *CLS, *RST, *SRE, *ESE, and STAT:PRES.

Design Rules

Design your IBASIC and External Controller with the following rules:

- Do not overlap commands between the external controller and IBASIC.
- Do not change status information which is expected by the alternate controller. Design programs such that status information does not overlap.

See the example program, `TRICTRL`, which implements a synchronization protocol between an external controller and two instruments running IBASIC programs.

Transferring Data Between Programs

Using OUTPUT and ENTER statements

All data sent from an external controller to the instrument's external port is received by the instrument and not by any program running in it. Therefore, a non-active controller IBASIC program can never enter or output data via the external interface. This means that in order to pass data between an external controller and an internal program using `OUTPUT` and `ENTER` statements, the internal program must be given active control and the external controller must become the non-active controller. HP IBASIC for Windows and HP BASIC controllers have the ability to enter and output data via HP-IB while acting as a non-active controller.

Note Moving data through the HP-IB and running a measurement in the host instrument at the same time can slow both operations significantly.

It is recommended that you do not perform these operations simultaneously.

One method of passing data between the two controllers is to set the instrument as Talker/Listener and run a program on the external controller that starts the IBASIC program and passes control to it. The IBASIC program can then output data to, and enter data from, the external controller. Two programs, that are listed in Chapter 11, "Example Programs," demonstrate how to transfer data between an internal program and an external controller program. The first program, `DATA_EXT`, is run from an external controller. It assumes that a disk containing the corresponding IBASIC program `DATA_INT` is in the disk drive of the analyzer. It remotely loads the IBASIC program, starts it and then transfers active control to it. The IBASIC program `DATA_INT`, with active control of the interface, queries the external program for name of the drive to catalog, and then outputs the catalogued string to the external program and passes active control back. After receiving the catalog data, the external program goes into a loop (line 1080) executing a command that continues to generate an error until the host computer again becomes active controller when control is passed back.

Setting and Querying Variables

Another means of transferring data between an internal and an external program involves the ability to set and query internal program variables from an external program. The "PROGram[:SELected]:NUMBer" and "PROGram[:SELected]:STRing" mnemonics (and their query counterparts) are part of the analyzer HP-IB commands. The internal program must not be running when these commands are executed.

The command

```
PROG:NUMB < string >, < value >
```

sets the value of a numeric variable in the program. The command

```
PROG:STR < string >, < value >
```

sets the value of a string variable in the program. In both the `PROG:NUMB` and `PROG:STR` commands and queries, `< string >` is the variable name and must be string data (in quotes). In the `PROG:STR` command, `< value >` is also string data (in quotes).

Numeric and string parameters can also be queried. The query

```
PROG:NUMBer? < string >
```

returns the value of the specified numeric variable.

Arrays of `REAL` or `INTEGER` type may be sent or queried but arrays of strings are not allowed. Array elements are separated by commas.

Examples

```
OUTPUT 716;"PROG:NUMBER 'Test',99"

OUTPUT @Ibasic;"PROG:STRING 'A$','String Data'"

OUTPUT 716;"PROG:NUMB? 'Iarray(*)'"
```

The following program segment sends both numeric and string variable queries and enters the resulting data:

```
10   ASSIGN @Prog TO 716
20   OUTPUT @Prog;"FORM ASCII,3"
30   OUTPUT @Prog;"PROG:NUMB? 'Test'"
40   ENTER @Prog; Testval
50   PRINT "The value of the variable Test = ";Testval
60   OUTPUT @Prog;"PROG:STR? 'A$'"
70   ENTER @Prog; Str$
80   PRINT "A$ = ";Str$
90   END
```

Downloading and Uploading Programs

Programs can be transferred between an external controller and program memory using the HP-IB download command "PROGram[:SELected]:DEFine" and its upload query "PROGram[:SELected]:DEFine?". Programs that use these mnemonics are run in the external controller.

Downloading

Program data transferred (downloaded) from the external controller to the instrument is always transferred as an "arbitrary block." The arbitrary block may be a definite length or indefinite length block. The indefinite length block is by far the easiest and is simply a block of data that begins with the characters "#0" preceding the first line and ends with a line-feed character accompanied by an EOI signal on the HP-IB interface.

When using the mnemonic PROG:DEF to download program lines, the #0 must not be followed by a line-feed. Each program line must have a line number at its beginning and a line-feed at its end. To end the arbitrary block of program lines, a single line-feed must be output with the OUTPUT END parameter, which sends the EOI (End or Identify) signal on the HP-IB control lines.

Refer to Chapter 11, "Example Programs" for a listing of the example program DOWNLOAD.

Notice that the OUTPUT statement on line 460 is terminated with a semicolon. This suppresses the line-feed that would otherwise occur.

As each line of the program is downloaded it is checked for syntax.

If an error is found, the error message is displayed on the CRT and the line is commented and checked for syntax again. If it still causes an error (for example the line may be too long) the line is discarded.

Any lines that currently exist in the memory buffer will remain unless they are overwritten by downloaded program lines. This makes it easy to edit lines in an external controller and then download only the edited lines into an existing program. If you want to completely overwrite the current program in memory, you must delete the program first. This can be done remotely using the extended command PROG:DEL:ALL (see line 350).

Uploading

The mnemonic PROG:DEF? is used to upload a program from the program buffer. The entire program is then returned as a definite length arbitrary block. A definite length block starts with the "#" character followed by a single digit defining the number of following digits to read as the block length.

Refer to Chapter 11, "Example Programs" for a listing of the example program UPLOAD, which demonstrates an uploading routine run on an external controller.

The subroutine **Openfile** (lines 570 through 770) creates an ASCII file to save the uploaded program to. The number of 256 byte records declared in the **CREATE ASCII** statement (line 730) is simply the file size (declared in the definite block header) divided by 256. Line 720 accommodates any remainder in this calculation by increasing the file size number by one record if any remainder exists.

Although this simple method works for many uploaded programs, there may still be a problem with the file size caused by the OUTPUT statement in line 490. This is because every ASCII line in a LIF file contains a two byte length header and possibly one additional pad byte to make the length an even number of bytes. These extra bytes are not included in the definite length block header information. You can account for this extra overhead by allocating an extra 10 to 15 percent of space when you create the ASCII file. For example, the **Openfile** subroutine could be rewritten as:

```
570 SUB Openfile(@File,Filename$,Fsize)
680   ON ERROR GOTO Openerr
715   Fsize=Fsize+(Fsize*0.15)
720   IF Fsize MOD 256>0 THEN Fsize=Fsize+256
730   CREATE ASCII Filename$,Fsize DIV 256
```

9

Using Subprograms

Analyzer products shipped with the IBASIC option can run subprograms. The subprograms may be user-created or built-in.

User-Created Subprograms

You can use the LOADSUB keyword with subprograms of your own creation. LOADSUB enables you to append subprograms to other programs and is supported as described in the RMB manual. When using LOADSUB, keep in mind the following:

- Subprograms must be stored to files using the STORE keyword when first created.
- Subprograms may be stored from the external keyboard or from the front panel if the [File Type] format is BIN.
- BIN type files are generally not transportable between the analyzer and other development systems (only ASCII files are compatible with other systems).

Typical examples of LOAD/STORE:

From an external keyboard:

LOAD "MYFILE"

STORE "MYFILE"

From the front panel:

(Save/Recall) Programs File Type BIN Save/Program

(Save/Recall) Programs File Type BIN Recall/Program

Typical examples of LOADSUB:

LOADSUB subprogram_name FROM "filename"

LOADSUB ALL FROM "filename"

User-created subprograms are appended to the end of the BASIC program currently stored in the EDIT buffer.

Built-In High-Speed Subprograms

You can use LOADSUB to access pre-compiled routines stored as instrument firmware in internal memory. Any IBASIC program running on the analyzer can access these subprograms; programs running on external computers cannot. The external program must use the equivalent code listed in the table below in place of a built-in subprogram.

IBASIC programs which use the built-in subprograms are simpler and run faster. For example, most data transfer operations run twice as fast when using the built-in subprograms; math operations run many times faster. Built-in subprograms are stored in memory designated as "MEM,0,0".

To access a subprogram, the subprogram first must be loaded into the main program using the LOADSUB keyword. The LOADSUB keyword requires a filename be specified from which to load the subprogram. Three built-in files are "XFER", "MATH", and "RPG".

- "XFER" file adds support to transfer trace data between the instrument and the IBASIC program.
- "MATH" file adds high speed support for complex array operations.
- "RPG" file adds fast RPG (rotary pulse generator — front panel knob) response for markers.

LOADSUB `<Subprogram name>` FROM `<Filename:MEM,0,0>` loads the named subprogram from the built-in file "FILENAME".

LOADSUB ALL FROM `<Filename:MEM,0,0>` loads all the subprograms in the named built-in file "FILENAME". See the following table for subprogram names within the files "XFER", "MATH", and "RPG".

Built-in Subprogram Description (Filenames found in :MEM,0,0)

Filename	Subprogram Name (parameter list)	Description
XFER	Read_fdata(INTEGER Chan,REAL A(*))	Read real formatted data
	Read_fmem(INTEGER Chan,REAL A(*))	Read real formatted mem
	Read_cdata(INTEGER Chan,REAL A(*))	Read complex data
	Read_cmem(INTEGER Chan,REAL A(*))	Read complex memory
	Write_fdata(INTEGER Chan,REAL A(*))	Write real formatted data
	Write_fmem(INTEGER Chan,REAL A(*))	Write real formatted mem.
	Write_cdata(INTEGER Chan,REAL A(*))	Write complex data
	Write_cmem(INTEGER Chan,REAL A(*))	Write complex memory
	Read_rdata(INTEGER Chan,Input$, REAL A(*))	Read raw complex data
	Write_rdata(INTEGER Chan,Input$,REAL A(*))	Write raw complex data
	Read_corr(INTEGER Chan, N,REAL A(*))	Read complex error coef.
	Write_corr(INTEGER Chan, N,REAL A(*))	Write complex error coef.
MATH		
Define Complex Array Operations	Cmplx_mag(REAL Cdata(*),Mag(*),INTEGER Sz)	Mag of complex array
	Cmplx_arg(REAL Cdata(*),Arg(*),INTEGER Sz) !Arg of complex array	
	Cmplx_conjg(REAL A(*),B(*)) !Complex conj of array A to B	
Define Complex Number Operations	Cadd(REAL Op1(*),INTEGER Row1,REAL Op2(*),INTEGER Row2,REAL Ans(*),INTEGER Rowans)	Complex Ans=Op1+Op2
	Csub(REAL Op1(*),INTEGER Row1,REAL Op2(*),INTEGER Row2,REAL Ans(*),INTEGER Rowans)	Complex Ans=Op1-Op2
	Cmul(REAL Op1(*),INTEGER Row1,REAL Op2(*),INTEGER Row2,REAL Ans(*),INTEGER Rowans)	Complex Ans=Op1*Op2
	Cdiv(REAL Op1(*),INTEGER Row1,REAL Op2(*),INTEGER Row2,REAL Ans(*),INTEGER Rowans)	Complex Ans=Op1/Op2
RPG	SUB Rpg_function (INTEGER function)	Redirect RPG & STEP keys function 0=normal 1=Actv MKR & INPUT 2=Actv MKR & LABELS

Example Programs

`1`	*Example use of built in subprograms*
`10 LOADSUB Read_fdata FROM "XFER:MEM,0,0"`	*Appends Read_data sub program to end of this program. This subprogram can now be called.*
`20`	
`30`	
`40`	
`50 REAL Trace_array(1:201)`	*Reads Channel 1 data into Trace_array(*)*
`60 Read_fdata( 1, Trace_array(*))`	
`70 LOADSUB ALL FROM "MATH:MEM,0,0"`	*Appends all math subprograms defined in "MATH" to the end of this program.*
`80 END`	
`90 SUB Read_fdata(INTEGER Chan,REAL A(*))`	*Read real formatted data.*
`100 SUB Cmplx_mag(REAL Cdata(*),Mag(*),INTEGER Sz)`	*Mag of complex array.*
`110 SUB Cmplx_arg(REAL Cdata(*),Arg(*),INTEGER Sz)`	*Arg of complex array.*
`120 ...`	

Note Built in subprograms cannot be edited since they are compiled and built into the firmware. However, any subprogram can be deleted by the DELSUB keyword support in revision 2 IBASIC.

RUNTIME Built in subprogram Errors

Number	Description
8,9,16	Improper or inconsistent dimensions found which specify array size. Using the wrong number of subscripts when referencing an array element.
983	Wrong type or number of parameters. An improper parameter list for a machine resident function.

Avoiding Multiple Loads of Subprograms

To avoid multiple LOADS of a subprogram which has already been loaded, the following example may be used.

```
10  ON ERROR GOTO 30
20  DELSUB Read_fdata
30  LOADSUB Read_fdata FROM "XFER:MEM,0,0"
40  OFF ERROR
```

10

IBASIC Keyword Summary

This chapter summarizes the HP Instrument BASIC keyword implementation in the analyzer. Table 10-1 is alphabetical. It indicates the type of support for each entry and notes exceptions, if any. Exceptions are major differences between the keywords descriptions in the "HP Instrument BASIC Language Reference" and their implementation in the analyzer. When differences are too extensive to be summarized, see the "HP Instrument BASIC Language Reference."

Table 10-2 contains the same information as Table 10-1, but is organized by category.

Table 10-1. Alphabetical List of IBASIC Keywords

HP IBASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
&	FP,EK,P	
*	EK,P	
+	EK,P	
-	EK,P	
/	K,P	
<.<=,<>,=,>,>=	P	
ABORT	EK,P	Select Code = 7,8,9,15
ABS	EK,P	
ACS	FP,EK,P	
ALLOCATE	EK,P	
AND	FP,EK,P	
ASN	FP,EK,P	
ASSIGN	EK,P	
ATN	FP,EK,P	
AXES	EK,P	
BEEP	EK,P	
BINAND	FP,EK,P	
BINCMP	FP,EK,P	
BINEOR	FP,EK,P	
BINIOR	FP,EK,P	
BIT	FP,EK,P	

Table 10-1. Alphabetical List of IBASIC Keywords (continued)

HP IBASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
CALL	EK,P	
CASE	P	
CASE ELSE	P	
CAT	FP,EK,P	Supports 58 columns. See manual.
CHR$	FP,EK,P	
CLEAR	EK,P	Select Code = 7,8,9,15
CLEAR SCREEN	EK,P	
CLS	EK,P	
COM	P	
CONT	EK,FP	Line number support from EK only
COPY	FP,EK,P	
COPYLINES	EK	
COS	FP,EK,P	Abs vals less than 1.7083127722e+10
CREATE		
CREATE ASCII	EK,P	
CREATE BDAT	EK,P	
CREATE DIR		
CRT	EK,P	ENTER CRT(ENTER 1) not supported
CSIZE	EK,P	
DATA	P	
DATE	EK,P	
DATE$	EK,P	
DEALLOCATE	EK,P	
DEF FN	P	
DEG	FP,EK,P	
DEL	FP,EK	Front Panel deletes only 1 line
DELSUB	EK,P	
DET	EK,P	
DIM	P	
DISABLE	P	
DISABLE INTR	P	Interface Select Code = 7 or 8
DISP	EK,P	
DIV	EK,P	
DOT	EK,P	
DRAW	EK,P	

Table 10-1. Alphabetical List of IBASIC Keywords (continued)

HP IBASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
DROUND	EK,P	
DUMP ALPHA	none	Use HPIB command
DVAL	FP,EK,P	
DVAL$	FP,EK,P	
EDIT	FP,EK	Front Panel EDITs default line #
ELSE	P	
ENABLE	P	
ENABLE INTR	P	Interface Select Code = 7 or 8
END	P	
END IF	P	
END LOOP	P	
END SELECT	P	
END WHILE	P	
ENTER	EK,P	
ERRL()	P	
ERRLN()	EK,P	
ERRM$	EK,P	
ERRN	EK,P	
EXIT IF	P	
EXOR	FP,EK,P	
EXP	EK,P	
FN	P	
FNEND	P	
FOR NEXT	P	
FRACT	EK,P	
FRAME	EK,P	
GCLEAR	EK,P	
GET	FP,EK,P	
GINIT	EK,P	
GOSUB	P	
GOTO	P	
GRID	EK,P	
IDRAW	EK,P	
IF THEN	P	

Table 10-1. Alphabetical List of IBASIC Keywords (continued)

HP IBASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
IMAGE	P	
IMOVE	EK,P	
INDENT	EK	
INITIALIZE	FP,EK,P	
INPUT	P	See Manual.
INT	EK,P	
INTEGER	P	
IPLOT	EK,P	
IVAL	FP,EK,P	
IVAL$	FP,EK,P	
KBD	P	Returns select code =2.
LABEL	EK,P	
LDIR	EK,P	
LEN	FP,EK,P	
LET	EK,P	
LGT	EK,P	
LIST	EK,P	Valid Device Selectors
LOAD	FP,EK,P	
LOADSUB	FP,EK,P	
LOADSUB ALL FROM ...	FP,EK,P	
LOCAL	EK,P	Select Code 7 only.
LOCAL LOCKOUT	EK,P	Select Code 7 only.
LOG	EK,P	
LOOP	P	
LORG	EK,P	
LWC$	FP,EK,P	
MAT	EK,P	
MAT REORDER	EK,P	
MAT REORDER ... BY	EK,P	
MAT foo=CSUM(bar)	EK,P	
MAT foo=IDN	EK,P	
MAT foo=INV(bar)	EK,P	
MAT foo=RSUM(bar	EK,P	

Table 10-1. Alphabetical List of IBASIC Keywords (continued)

HP IBASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
MAX	EK,P	
MAXLEN	FP,EK,P	
MAXREAL	EK,P	
MIN	EK,P	
MINREAL	EK,P	
MOD	EK,P	
MODULO	EK,P	
MOVE	EK,P	
MOVELINES	EK	
MSI	FP,EK,P	MSI may be altered by the instr.
NOT	FP,EK,P	
NUM	FP,EK,P	
ON|OFF CYCLE	P	
ON|OFF ERROR	P	
ON|OFF INTR	P	Interface Select Code = 7 or 8
ON|OFF KEY	P	Key selectors 1 through 7
ON|OFF TIMEOUT	P	Interface Select Code = 7 or 8
OPTION BASE	P	
OR	FP,EK,P	
OUTPUT	EK,P	Select Code 1,7,8
PASS CONTROL	EK,P	Select Code 7 or 8
PAUSE	EK,FP,P	
PDIR	EK,P	
PEN	EK,P	0=erase 1=draw
PENUP	EK,P	
PI	EK,P	
PIVOT	EK,P	
PLOT	EK,P	
POLYGON	EK,P	FILL not supported. Scaling diffs.
POLYLINE	EK,P	
POS	FP,EK,P	
PRINT	EK,P	
PRINTER IS	EK,P	
PROUND	EK,P	

Table 10-1. Alphabetical List of IBASIC Keywords (continued)

HP IBASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
PRT	EK,P	
PURGE	FP,EK,P	
RAD	FP,EK,P	
RANDOMIZE	EK,P	
RATIO	EK,P	
RE-SAVE	FP,EK,P	
RE-STORE	FP,EK,P	
READ	EK,P	
READIO	EK,P	Select Code 9 or 15. See manual.
REAL	P	
RECTANGLE	EK,P	FILL not supported. Scaling diffs.
REDIM	EK,P	
REM	P	
REMOTE	EK,P	Select Code 7
REN	EK	
RENAME	FP,EK,P	
REPEAT UNTIL	P	
RESTORE	P	
RETURN	P	
REV$	FP,EK,P	
RND	EK,P	
ROTATE	FP,EK,P	
RPLOT	EK,P	Fill not supported. Scaling diffs.
RPT$	FP,EK,P	
RUN	EK,FP,P	
SAVE	FP,EK,P	
SCRATCH	FP,EK	Front Panel executes SCRATCH A.
SECURE	FP,EK	
SELECT	P	
SET TIME foo	FP,EK,P	
SET TIMEDATE foo	EK,P	
SGN	EK,P	
SHIFT	FP,EK,P	
SHOW	EK,P	

Table 10-1. Alphabetical List of IBASIC Keywords (continued)

HP IBASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
SIN	FP,EK,P	
SPOLL	EK,P	Select Code 7
SQR	EK,P	
SQRT	EK,P	
STEP	FP,EK	
STOP	FP,P	
STORE	FP,EK,P	
SUB	P	
SUBEND	P	
SUBEXIT	P	
SUM	EK,P	
SYSTEM PRIORITY	P	
SYSTEM$	EK,P	
TAB()	EK,P	
TABXY()	EK,P	
TAN	FP,EK,P	
TIME	EK,P	
TIME$	EK,P	
TRIGGER	EK,P	Select Code 7
TRIM$	FP,EK,P	
TRN	EK,P	
UPC$	FP,EK,P	
USING	EK,P	
VAL	FP,EK,P	
VAL$	FP,EK,P	
VIEWPORT	EK,P	
WAIT	EK,P	
WHERE	EK,P	
WHILE	P	
WIDTH	EK,P	
WINDOW	EK,P	
WRITEIO	EK,P	Select Code 9 or 15. See manual.
^	EK,P	

Table 10-2. Categorical List of IBASIC Keywords

HP Instrument BASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
Program Entry/Editing		
COPYLINES	EK	
DEL	FP,EK	Front Panel deletes only 1 line.
DELSUB	EK	
EDIT	FP,EK	Front Panel EDITs default line #. See Manual.
INDENT	EK	
LIST	EK,P	Valid Device Selectors #7xx, #7xxxx, #9, #15.
MOVELINES	EK	
REM	P	
REN	EK	
SECURE	FP,EK	
Program Debugging		
ERRL()	P	
ERRLN()	EK,P	
ERRM$	EK,P	
ERRN	EK,P	
STEP	FP,EK	
Memory Allocation		
ALLOCATE	EK,P	
COM	P	
DEALLOCATE	EK,P	
DELSUB	EK,P	
DIM	P	
INTEGER	P	
LOADSUB	EK,P	
OPTION BASE	P	
REAL	P	
SCRATCH	FP,EK	Front Panel executes SCRATCH A.
Relational Operators		
<.<=,<>,=,>,>=	P	
General Math		
*	EK,P	
+	EK,P	
-	EK,P	
/	EK,P	

Table 10-2. Categorical List of IBASIC Keywords (continued)

HP Instrument BASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
ABS	EK,P	
DIV	EK,P	
DROUND	EK,P	
EXP	EK,P	
FRACT	EK,P	
INT	EK,P	
LET	EK,P	
LGT	EK,P	
LOG	EK,P	
MAX	EK,P	
MAXREAL	EK,P	
MIN	EK,P	
MINREAL	EK,P	
MOD	EK,P	
MODULO	EK,P	
PI	EK,P	
PROUND	EK,P	
RANDOMIZE	EK,P	
RND	EK,P	
SGN	EK,P	
SQR	EK,P	
SQRT	EK,P	
^	EK,P	
Binary Functions		
BINAND	FP,EK,P	
BINCMP	FP,EK,P	
BINEOR	FP,EK,P	
BINIOR	FP,EK,P	
BIT	FP,EK,P	
ROTATE	FP,EK,P	
SHIFT	FP,EK,P	
Trigonometric Operations		
ACS	FP,EK,P	
ASN	FP,EK,P	
ATN	FP,EK,P	
COS	FP,EK,P	Abs vals less than 1.7083127722e+10
DEG	FP,EK,P	

Table 10-2. Categorical List of IBASIC Keywords (continued)

HP Instrument BASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
RAD	FP,EK,P	
SIN	FP,EK,P	
TAN	FP,EK,P	
String Operations		
&	FP,EK,P	
CHR$	FP,EK,P	
DVAL$	FP,EK,P	
DVAL	FP,EK,P	
IVAL$	FP,EK,P	
IVAL	FP,EK,P	
LEN	FP,EK,P	
LWC$	FP,EK,P	
MAXLEN	FP,EK,P	
NUM	FP,EK,P	
POS	FP,EK,P	
REV$	FP,EK,P	
RPT$	FP,EK,P	
TRIM$	FP,EK,P	
UPC$	FP,EK,P	
VAL$	FP,EK,P	
VAL	FP,EK,P	
Logical Operations		
AND	FP,EK,P	
EXOR	FP,EK,P	
NOT	FP,EK,P	
OR	FP,EK,P	
Mass Storage		
CAT	FP,EK,P	Supports 58 columns. See manual.
COPY	FP,EK,P	
CREATE		
CREATE ASCII	EK,P	
CREATE BDAT	EK,P	
CREATE DIR		
GET	FP,EK,P	

Table 10-2. Categorical List of IBASIC Keywords (continued)

HP Instrument BASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptious
INITIALIZE	FP,EK,P	
LOAD	FP,EK,P	
LOADSUB	FP,EK,P	
LOADSUB ALL FROM ...	FP,EK,P	
MSI	FP,EK,P	MSI may be altered by the instr. When save/recalling programs to/from DOS subdirectories.
PURGE	FP,EK,P	
RE-SAVE	FP,EK,P	
RENAME	FP,EK,P	
RE-STORE	FP,EK,P	
SAVE	FP,EK,P	
STORE	FP,EK,P	
Program Control		
CALL	EK,P	
CASE	P	
CASE ELSE	P	
CONT	EK,FP	Line number support from EK only
DEF FN	P	
ELSE	P	
END	P	
END IF	P	
END LOOP	P	
END SELECT	P	
END WHILE	P	
EXIT IF	P	
FN	P	
FNEND	P	
FOR NEXT	P	
GOSUB	P	
GOTO	P	
IF THEN	P	
LOOP	P	
PAUSE	EK,FP,P	
REPEAT UNTIL	P	

Table 10-2. Categorical List of IBASIC Keywords (continued)

HP Instrument BASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
RETURN	P	
RUN	EK,FP,P	
SELECT	P	
STOP	FP,P	
SUB	P	
SUBEND	P	
SUBEXIT	P	
SYSTEM$	EK,P	
WAIT	EK,P	
WHILE	P	
Event Initiated Branching		
DISABLE	P	
DISABLE INTR	P	Interface Select Code = 7 or 8.
ENABLE	P	
ENABLE INTR	P	Interface Select Code = 7 or 8. Must not precede an ON INTR statement.
ON|OFF CYCLE	P	
ON|OFF ERROR	P	
ON|OFF INTR	P	Interface Select Code = 7 or 8. Must precede ENABLE INTR statement.
ON|OFF KEY	P	Key selectors 1 through 7
ON|OFF TIMEOUT	P	Interface Select Code = 7 or 8
SYSTEM PRIORITY	P	
Graphics Control		
GCLEAR	EK,P	
GINIT	EK,P	
RATIO	EK,P	
SHOW	EK,P	
VIEWPORT	EK,P	
WHERE	EK,P	
WINDOW	EK,P	
Graphics Plotting		
DRAW	EK,P	
IDRAW	EK,P	
IMOVE	EK,P	

Table 10-2. Categorical List of IBASIC Keywords (continued)

HP Instrument BASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
IPLOT	EK,P	
MOVE	EK,P	
PDIR	EK,P	
PEN	EK,P	0=erase 1=draw
PENUP	EK,P	
PIVOT	EK,P	
PLOT	EK,P	
POLYGON	EK,P	FILL not supported. Scaling diffs.
POLYLINE	EK,P	
RECTANGLE	EK,P	FILL not supported. Scaling diffs.
RPLOT	EK,P	FILL not supported. Scaling diffs.
Graphics Axis and Labeling		
AXES	EK,P	
CSIZE	EK,P	
FRAME	EK,P	
GRID	EK,P	
LABEL	EK,P	
LDIR	EK,P	
LORG	EK,P	
HP-IB Control		
ABORT	EK,P	Select Code = 7,8,9,15
CLEAR	EK,P	Select Code = 7,8,9,15
LOCAL	EK,P	Select Code 7 only.
LOCAL LOCKOUT	EK,P	Select Code 7 only.
PASS CONTROL	EK,P	Select Code 7 or 8
REMOTE	EK,P	Select Code 7
SPOLL	EK,P	Select Code 7
TRIGGER	EK,P	Select Code 7
Clock and Calendar		
DATE	EK,P	
DATE$	EK,P	
SET TIME foo	FP,EK,P	
SET TIMEDATE foo	EK,P	
TIME	EK,P	
TIME$	EK,P	

Table 10-2. Categorical List of IBASIC Keywords (continued)

HP Instrument BASIC Keyword	Support FP=Front Panel EK=External Keyboard P=Programmable	Exceptions
General Device Input/Output		
ASSIGN	EK,P	
BEEP	EK,P	
CRT	EK,P	ENTER CRT(ENTER 1) not supported
DATA	P	
DISP	EK,P	
ENTER	EK,P	
IMAGE	P	
INPUT	P	See Manual.
KBD	P	Returns select code =2.
OUTPUT	EK,P	Select Code 1,7,8
PRINT	EK,P	
PRINTER IS	EK,P	
PRT	EK,P	
READ	EK,P	
READIO	EK,P	Select Code 9 or 15. See manual.
RESTORE	P	
TAB()	EK,P	
TABXY()	EK,P	
USING	EK,P	
WIDTH	EK,P	
WRITEIO	EK,P	Select Code 9 or 15. See manual.
Display and Keyboard Control		
CLEAR SCREEN	EK,P	
CLS	EK,P	
Array Operations		
DET	EK,P	
DOT	EK,P	
MAT	EK,P	
MAT foo=IDN	EK,P	
MAT foo=INV(bar)	EK,P	
MAT foo=CSUM(bar)	EK,P	
MAT foo=RSUM(bar)	EK,P	
MAT REORDER	EK,P	
MAT REORDER ... BY	EK,P	
REDIM	EK,P	
SUM	EK,P	
TRN	EK,P	

11

Example Programs

Example Program Summaries

This chapter contains listings of the example programs referred to throughout this manual. These programs are all available on the *IBASIC Example Programs Disk* that accompanies this manual.

In addition to these example programs, there are two additional disks of examples for the analyzer. These disks are the *Example Programs Disk — DOS Format* and the *Example Programs Disk — LIF Format*. These disks are included with the network analyzer when it is delivered. All the programs on these disks are designed to run on the analyzer's internal IBASIC controller.

The example programs on the *IBASIC Example Programs Disk*, some of which are listed in this chapter, include the following:

DATA_EXT — Data transfer between internal and external programs

This program is designed to run on an external controller — either HP IBASIC for Windows running on a PC or HP BASIC running on an HP workstation.

This program demonstrates how to transfer data from an IBASIC program running on the analyzer to an HP BASIC or IBASIC program running externally. It loads a program into the HP 8711, runs it, sets a variable and then gives it control of the bus. This program then acts as a device on the bus (sending and receiving data).

DATA_INT — Data transfer between internal and external programs

This program is designed to run on the analyzer's internal IBASIC controller.

This program demonstrates how to transfer data to and from an external controller. In this example a catalog listing is transferred from the analyzer to the external controller. A numeric variable value is also downloaded from the external controller to the analyzer's program.

DOWNLOAD — Download program to analyzer

This program demonstrates how to download an IBASIC program to the analyzer. It is designed (in HP BASIC or HP IBASIC for Windows) to run on an external workstation or PC.

DRAW871X — Drawing setup diagrams

This program draws the network analyzer and a device under test to the full screen IBASIC display partition. The drawing can be scaled to fit the application. This program uses the analyzer's graphics commands for drawing. To use the IBASIC drawing commands, see the "BARCODE" program.

DUALCTRL — Two controller operation

This program demonstrates how the external controller and HP IBASIC can work together. It is designed to run on an external controller (in HP BASIC or HP IBASIC for Windows). The program downloads an IBASIC program to the analyzer and runs it twice. After each run, two program variables are read from the analyzer and displayed.

REPORT — Using the parallel port

This program uses the analyzer to generate a report, making a hardcopy on a printer connected to the parallel port. It uses a subprogram to send the output to the parallel port one line at a time. Before using this program, be sure that your printer is configured to ignore the Printer_select Centronics signal, since the `WRITEIO` command does not assert this signal.

TRICTRL — External controller with local IBASIC controllers

This example program demonstrates how an external controller can be used with two instruments running IBASIC. Run this program on an external controller. Connect two instruments via HP-IB cables to the external controller. Set one instrument to address 16, set the other instrument to address 18.

This program insures that only the analyzer or the local IBASIC is sending SCPI commands at one time. This is one possible implementation of synchronizing the analyzer and a controller. Refer to "Automating Measurements" in the *User's Guide*.

The external controller is responsible for downloading the IBASIC program to each analyzer. The external controller sets the status reporting to send a SRQ whenever a user requested service request occurs.

When all instrument configuration has completed, the external controller sends a "run program" command to each analyzer and then goes into an idle loop. The external controller remains in the idle loop until either instrument sends an SRQ.

While the external controller is idle, each instrument can freely send various SCPI commands. Each instrument may ask for service by triggering an SRQ. Once a SRQ has been triggered, the instrument must remain in an idle loop, until the external controller indicates it is done servicing the SRQ. This is done using the program variable "Ctlr_flag". The flag is cleared when the external controller is done and has returned to its idle loop.

UPLOAD — Upload program from analyzer

This program uploads the IBASIC program in the analyzer's program buffer to an ASCII file on the external controller's current mass storage device.

USERBEG — Set up user-defined User BEGIN softkeys

This program creates User BEGIN softkeys which allow the user to Save or Recall one of two instrument states, set the marker to maximum, set the scale/div, and compute some measurement statistics at the marker.

USERBEG1 — The default User BEGIN program

The default User BEGIN program is created automatically when there is no IBASIC program installed. In this default program, softkey 3 is defined to be the marker-to-max function; softkey 4 prompts the user for a title, and also enables the clock. You may edit this program to change the functions you need.

USERBEG2 — Fast recall of instrument states

This example program demonstrates the fast recall of previously defined instrument states. The instrument states SETUP1, SETUP2, and SETUP3 must have been previously saved to the analyzer's internal non-volatile RAM disk. Load the program into the analyzer. Then press the (BEGIN) key. Enable the user-defined (BEGIN) by pressing User BEGIN ON. When User BEGIN is enabled, the (BEGIN) softkeys will be labeled "Setup1," "Setup2," and "Setup3." To recall each setup, select the appropriate softkey.

USER_BIT — Using the USER bit

This program demonstrates how to read and write to the USER bit. The USER bit is a TTL signal accessible by a BNC connector on the analyzer's rear panel. IBASIC's graphics commands are used to draw the USER bit value to the display.

USERKEYS — Customized softkeys

This program provides an example of how the analyzer's softkeys can be customized. The example demonstrates how to set up six instrument states, store them to the analyzer's internal memory, and setup two interactive softkey menus to choose between them.

BARCODE, STATS, DATALOG — Bar Code Programs

You may use bar code readers to simplify your measurement setups. The HPCK-1210 KeyWand scanner or compatible bar code scanner will work with the analyzer. Connect your bar code scanner to the DIN keyboard connector. You may connect a keyboard or other DIN key input device in parallel with the bar code scanner. The bar code scanner will work in place of, or in addition to, your keyboard.

The INPUT statement is used to read the bar code from the scanner. When the input statement is encountered, the program will wait until the user has completed an input. The input is completed whenever a carriage return is received from the keyboard or a bar code has been successfully scanned by the bar code scanner.

The following three programs, designed to run on the analyzer's internal IBASIC controller, demonstrate the use of bar code scanner applications as well as other useful applications. While a bar code scanner is useful in demonstrating these programs, it is not required; one can simply press ENTER and the program will input default values. Sample bar codes are provided for experimentation at the end of this chapter.

The three programs are as follows:

BARCODE - This program demonstrates basic bar code scanning to select one of three filter setups depending upon what is scanned. RF stimulus is set and response limits are read, set and tested for each device. Depending upon result, the program prints "PASS" or "FAIL" on the CRT. Most useful in this program is a subprogram to draw an analyzer representation on the CRT. This code can be re-used in any user application that may require a guided setup.

The analyzer image (and DUT image) can be both scaled to any size, and offset in the X or Y axis as required. This is an excellent program to familiarize yourself with graphic routines using IBASIC graphics commands.

STATS - This program first reads a DUT bar code and sets the RF stimulus accordingly. It then displays a running average of all similar devices and constantly updates the display with both the current DUT and the current average of all devices tested so far. Also demonstrates the use of two of the built-in CSUB routines for reading and writing trace data from/to the analyzer.

DATALOG - This program will very quickly store measured trace data for one of three filters to internal analyzer memory in a format that can be read by spreadsheet programs for further analysis. Because the data is stored to RAM, the time delay inherent with disks is not an issue; trace data can be stored in a fraction of a second. With 101 data points per trace selected, the internal memory will hold over 200 device test results. At this point, the program automatically transfers the data to disk. Of course, more data points will take longer to store and fill the memory sooner. The program will read the bar code and select the stimulus accordingly. It then measures the device and upon request, stores it under a unique name dependent upon model number and serial number. Once the internal memory is full, or at any user requested time, all trace data is transferred to disk.

ADJ_110 — Automated procedure for service adjustment #110 (B* amplitude correction)

This program is provided as a servicing tool to automate the B* adjustment routine using IBASIC instead of using an external controller. Description of this program is provided in the adjustment portion of the service manual. Because this program was not intended to be an example program and due to its length (>1200 lines), the program listing is not provided here. However, there are several routines that may be useful in other applications. The following subprograms and functions may be of particular interest.

FNSelect$
: A routine that allows selection of one of many possible choices by scrolling an arrow down the list of choices. The number of choices may exceed one screen. The front panel hard keys or knob can be used for scrolling. In addition, user defined softkeys can also be chosen. The user has the option of using the front panel keyboard or an external AT style keyboard. With a slight modification, described within the code, this routine can also be used on an HP RMB controller (e.g. an HP 9000 Series 300 computer).

FNSel_softkey$
: A routine that displays a user defined message and allows the operator to select one of seven possible softkeys.

FNYes
: A simple program that displays a user defined question and allows the user to select a YES or NO answer via the softkeys. Returns the number 1 for YES and 0 for NO.

Softpause
: Another simple routine that displays a user defined message and waits for the operator to press a RESUME softkey.

Note These routines require the Beeper and/or the Clear_screen subprograms which are also part of this program. However, both can be replaced with their IBASIC equivalent commands (BEEP and CLEAR SCREEN).

DATA_EXT — Data transfer between internal and external programs

```
10    !-----------------------------------------------------
20    !
30    ! BASIC program:  DATA_EXT - Data transfer (external)
40    !
50    ! This program demonstrates how to transfer data from
60    ! an IBASIC program running on the HP 8711 to an
70    ! HP BASIC program (or an IBASIC program running
80    ! externally).  This program was designed to run on a
90    ! computer or PC.  It loads a program into the HP 8711,
100   ! runs it, and then gives it control of the bus.
110   ! This program then acts as a device on the bus;
120   ! sending and receiving data.
130   !
140   ! Before running this program, a disc with the program
150   ! 'DATA_INT' should be in the HP 8711's internal drive.
160   !
170   !-----------------------------------------------------
180   !
190   ! Initialize variables for the interface select code
200   ! and the HP-IB address of the HP 8711.
210   !
220   Scode=7
230   Address=16
240   Na=Scode*100+Address
250   !
260   ! Abort any bus traffic, clear the input/output queues
270   ! of the analyzer, clear the analyzer's status
280   ! registers and the display.
290   !
300   ABORT Scode
310   CLEAR Na
320   OUTPUT Na;"*CLS"
330   CLEAR SCREEN
340   !
350   ! Dimension an array to hold the catalog listing.
360   !
370   DIM Directory$(1:100)[85]
380   !
390   ! Prompt the operator to insert the disk in the
400   ! HP 8711, load the program and wait until done.
410   !
420   INPUT "Put disc with program 'DATA_INT' into the HP 8711.  Pr
ess <ENTER>",A$
430   DISP "Loading program on HP 8711 . . ."
440   OUTPUT Na;"PROG:EXEC 'GET ""DATA_INT:INTERNAL""'"
450   OUTPUT Na;"*OPC?"
```

```
460   ENTER Na;Opc
470   !
480   ! Read the analyzer's event status register and
490   ! check for any errors when loading file.
500   !
510   OUTPUT Na;"*ESR?"
520   ENTER Na;Esr
530   IF Esr>0 THEN
540     BEEP
550     DISP "Error occurred while loading 'DATA_INT' . . . Program
stopped."
560     STOP
570   END IF
580   !
590   ! Determine the HP-IB address of the controller
600   ! and set the pass control back address.
610   !
620   INTEGER Stat,Addr
630   STATUS 7,3;Stat
640   Addr=BINAND(Stat,31)
650   OUTPUT Na;"*PCB ";Addr
660   !
670   ! Send the command to run the DATA_INT program.
680   !
690   DISP "Running the program..."
700   OUTPUT Na;"PROG:STAT RUN"
710   !
720   ! Monitor the program's status.  When it has
730   ! paused, set the variable for the controller's
740   ! HP-IB address.
750   !
760   OUTPUT Na;"PROG:STAT?"
770   ENTER Na;Prog$
780   IF Prog$"PAUS" THEN GOTO 760
790   OUTPUT Na;"PROG:NUMB 'Host',";Scode*100+Addr
800   OUTPUT Na;"PROG:STAT CONT"
810   !
820   ! Pass control of the bus to the HP 8711.
830   !
840   PASS CONTROL Na
850   !
860   ! Wait until addressed to talk by the HP 8711,
870   ! then send the name of the disk to catalog.
880   !
890   OUTPUT Scode;":INTERNAL"
900   !
910   ! Wait until addressed to listen by the HP 8711,
920   ! then read the directory from the analyzer.
930   !
940   DISP "Reading data . . ."
950   ENTER Scode;Directory$(*)
```

```
960   !
970   ! Print the catalog to the controller's display.
980   !
990   FOR I=1 TO 100
1000    IF LEN(Directory$(I))>0 THEN PRINT Directory$(I)
1010  NEXT I
1020  !
1030  ! Try to return the HP 8711 to LOCAL control.
1040  ! If the analyzer is still the active controller
1050  ! an error will be generated and the program
1060  ! will loop until control of the bus is received.
1070  !
1080  ON ERROR GOTO 1090
1090  LOCAL Na
1100  DISP ""
1110  END
```

DATA_INT — Data transfer between internal and external programs

```
10    !-------------------------------------------------------
20    !
30    ! IBASIC program:  DATA_INT - Data transfer (internal)
40    !
50    ! This program demonstrates how to transfer data to
60    ! and from an external controller.  In this example a
70    ! catalog listing is transferred from the HP 8711 to
80    ! the external controller.  For more information look
90    ! at the program listing for 'DATA_EXT'.
100   !
110   ! This IBASIC program is intended to run on the
120   ! HP 8711's internal controller.
130   !
140   !-------------------------------------------------------
150   !
160   ! Dimension an array to hold the catalog listing.
170   !
180   DIM Directory$(1:100)[85]
190   !
200   ! Pause the program and wait for the controller to
210   ! set the 'Host' variable with its' HP-IB address.
220   ! The controller continues this program after the
230   ! variable has been passed.
240   !
250   Host=0
260   PAUSE
270   !
280   ! Address the external controller to talk, read
290   ! the device to catalog.  If the HP 8711 is not
300   ! active controller on the bus an error will occur
310   ! and the program will loop until control is
320   ! received.
330   !
340   ON ERROR GOTO 340
350   ENTER Host;Stor_dev$
360   OFF ERROR
370   !
380   ! Catalog the requested storage device into
390   ! the string array.
400   !
410   DISP "Reading catalog..."
420   CAT Stor_dev$ TO Directory$(*)
430   !
440   ! Address the external controller to listen,
450   ! send the catalog array to the controller.
460   !
470   DISP "Transferring data..."
480   OUTPUT Host;Directory$(*)
490   !
```

```
500   ! Pass control back to the external controller.
510   !
520   PASS CONTROL Host
530   DISP "DONE"
540   END
```

DOWNLOAD — Download program to analyzer

```
10    !-------------------------------------------------------
20    !
30    ! BASIC program:  DOWNLOAD - Download program to Rfna
40    !
50    ! This program demonstrates how to download an IBASIC
60    ! program to the 871x.  This program is designed to
70    ! run on an external controller.
80    !
90    !-------------------------------------------------------
100   !
110   ! Initialize variables for the interface select code
120   ! and the HP-IB address of the HP 8711.
130   !
140   Scode=7
150   Address=16
160   Na=Scode*100+Address
170   !
180   ! Initialize variables, abort any bus traffic and
190   ! clear the input/output queues of the analyzer.
200   !
210   DIM Line$[255]
220   ABORT Scode
230   CLEAR Na
240   !
250   ! Get the program's filename and open the file.
260   !
270 Get_filename: INPUT "Program to be transferred?",Filename$
280   ON ERROR GOTO No_file
290   DISP "Checking file . . ."
300   ASSIGN @Basic_prog TO Filename$;FORMAT ON
310   OFF ERROR
320   !
330   ! Clear the contents of the analyzer's program buffer.
340   !
350   OUTPUT Na;"PROG:DEL:ALL"
360   !
370   ! Change the EOL (end of line) character to line feed
380   ! and initialize the line counter.
390   !
400 Transfer: ASSIGN @Prog TO Na;EOL CHR$(10)
410   Line_count=0
420   !
430   ! Initiate the program transfer (an indefinite length
440   ! block data transfer).
450   !
460   OUTPUT @Prog;"PROG:DEF #0";
470   !
```

```
480   ! Read each program line from the file and send it to
490   ! the HP 8711.  Loop until the end of file is reached.
500   !
510   ON ERROR GOSUB End_file
520   LOOP
530     ENTER @Basic_prog;Line$
540     OUTPUT @Prog;Line$
550     Line_count=Line_count+1
560     DISP "Lines transferred: ";Line_count
570   END LOOP
580   !
590   ! End the data transfer (output a line feed with EOI)
600   ! and close the file.  Return the analyzer to LOCAL
610   ! control and stop this program.
620   !
630 End_block: OUTPUT @Prog;CHR$(10) END
640   ASSIGN @Basic_prog TO *
650   DISP "Transfer complete"
660   LOCAL Na
670   STOP
680   !
690   ! This subroutine is the error handler for opening
700   ! the file - if the file won't open it returns to
710   ! get a new file name.
720   !
730 No_file: BEEP
740   DISP "CAN'T OPEN: """;Filename$;""" -- ";
750   GOTO Get_filename
760   RETURN
770   !
780   ! This subroutine is the error handler for the
790   ! data transfer.  When the end of file is reached
800   ! it generates an error.  Execution is resumed
810   ! outside of the transfer loop.
820   !
830 End_file: IF ERRN=59 THEN GOTO End_block
840   DISP ERRM$;" occured during data transfer"
850   STOP
860   RETURN
870   END
```

DRAW871X — Drawing setup diagrams

```
10   !-------------------------------------------------------
20   !
30   ! IBASIC program:  DRAW871X - Drawing setup diagrams
40   !
50   ! This program draws the HP 871X network analyzer
60   ! and a device under test to the full screen IBASIC
70   ! display partition.  The drawing can be scaled to
80   ! fit the application.  Setting the scale factor to
90   ! 1.0 creates a drawing of about 400 pixels wide
100  ! (1/2 screen width) and 100 pixels high (1/3 screen
110  ! height).
120  !
130  !-------------------------------------------------------
140  !
150  ! Setup an I/O path name for the internal bus and
160  ! declare variables.
170  !
180  INTEGER X0,Y0
190  REAL Scale
200  ASSIGN @Rfna TO 800
210  !
220  ! Preset the analyzer and wait until it is done.
230  !
240  OUTPUT @Rfna;"SYST:PRES;*OPC?"
250  ENTER @Rfna;Opc
260  !
270  ! Allocate the full screen as an IBASIC display
280  ! and clear the graphics buffer.
290  !
300  OUTPUT @Rfna;"DISP:PROG FULL"
310  OUTPUT @Rfna;"DISP:WIND10:GRAP:CLEAR"
320  !
330  ! Setup the origin and scale parameters for the
340  ! drawing.  Draw the network analyzer and dut.
350  !
360  X0=100
370  Y0=100
380  Scale=1.
390  CALL Draw_na(X0,Y0,Scale)
400  CALL Draw_dut(X0,Y0,Scale)
410  END
420  !-------------------------------------------------------
430  SUB Draw_na(INTEGER X0,INTEGER Y0,REAL Sc)
440    !-----------------------------------------------------
450    !
460    ! This subroutine draws the HP 8711 at origin X0,Y0
470    ! and scale Sc.  The drawing is done to the IBASIC
```

```
480     ! display (window 10) using the HP 8711's user
490     ! graphics commands.
500     !
510     !------------------------------------------------
520     ASSIGN @Rfna TO 800
530     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0)&","&VAL$(Y0
)
540     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*350))&"
,"&VAL$(INT(Sc*100))
550     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*10))&
","&VAL$(Y0+INT(Sc*10))
560     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*180))&",
"&VAL$(INT(Sc*80))
570     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*200))
&","&VAL$(Y0+INT(Sc*80))
580     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*15))&","
&VAL$(INT(Sc*8))
590     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*200))
&","&VAL$(Y0+INT(Sc*70))
600     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*15))&","
&VAL$(INT(Sc*8))
610     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*200))
&","&VAL$(Y0+INT(Sc*60))
620     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*15))&","
&VAL$(INT(Sc*8))
630     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*200))
&","&VAL$(Y0+INT(Sc*50))
640     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*15))&","
&VAL$(INT(Sc*8))
650     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*200))
&","&VAL$(Y0+INT(Sc*40))
660     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*15))&","
&VAL$(INT(Sc*8))
670     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*200))
&","&VAL$(Y0+INT(Sc*30))
680     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*15))&","
&VAL$(INT(Sc*8))
690     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*200))
&","&VAL$(Y0+INT(Sc*20))
700     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*15))&","
&VAL$(INT(Sc*8))
710     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*200))
&","&VAL$(Y0+INT(Sc*10))
720     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*15))&","
&VAL$(INT(Sc*8))
730     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*265))
&","&VAL$(Y0+INT(Sc*80))
740     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*70))&","
&VAL$(INT(Sc*13))
750     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*230))
&","&VAL$(Y0+INT(Sc*81))
```

```
760     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*20))&","
&VAL$(INT(Sc*10))
770     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*275))
&","&VAL$(Y0+INT(Sc*85))
780     OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*50))&","
&VAL$(INT(Sc*3))
790     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*295))
&","&VAL$(Y0+INT(Sc*50))
800     OUTPUT @Rfna;"DISP:WIND10:GRAP:CIRC "&VAL$(INT(Sc*8))
810     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*245))
&","&VAL$(Y0+INT(Sc*15))
820     OUTPUT @Rfna;"DISP:WIND10:GRAP:CIRC "&VAL$(INT(Sc*4))
830     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*325))
&","&VAL$(Y0+INT(Sc*15))
840     OUTPUT @Rfna;"DISP:WIND10:GRAP:CIRC "&VAL$(INT(Sc*4))
850   SUBEND
860   !----------------------------------------------------
870   SUB Draw_dut(INTEGER X0,INTEGER Y0,REAL Sc)
880     !--------------------------------------------------
890     !
900     ! This subprogram draws a device under test (dut)
910     ! and connects it to the HP 8711 that was drawn
920     ! with an origin at X0,Y0 and a scale of Sc.
930     !
940     !--------------------------------------------------
950     ASSIGN @Rfna TO 800
960     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*245))
&","&VAL$(Y0+INT(Sc*15))
970     OUTPUT @Rfna;"DISP:WIND10:GRAP:DRAW "&VAL$(X0+INT(Sc*245))
&","&VAL$(Y0-INT(Sc*20))
980     OUTPUT @Rfna;"DISP:WIND10:GRAP:DRAW "&VAL$(X0+INT(Sc*265))
&","&VAL$(Y0-INT(Sc*20))
990     OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*265))
&","&VAL$(Y0-INT(Sc*22))
1000    OUTPUT @Rfna;"DISP:WIND10:GRAP:RECT "&VAL$(INT(Sc*40))&","
&VAL$(INT(Sc*4))
1010    OUTPUT @Rfna;"DISP:WIND10:GRAP:MOVE "&VAL$(X0+INT(Sc*305))
&","&VAL$(Y0-INT(Sc*20))
1020    OUTPUT @Rfna;"DISP:WIND10:GRAP:DRAW "&VAL$(X0+INT(Sc*325))
&","&VAL$(Y0-INT(Sc*20))
1030    OUTPUT @Rfna;"DISP:WIND10:GRAP:DRAW "&VAL$(X0+INT(Sc*325))
&","&VAL$(Y0+INT(Sc*15))
1040  SUBEND
```

DUALCTRL — Two controller operation

```
10    !-----------------------------------------------------
20    !
30    ! BASIC program:  DUALCTRL - Two controller operation
40    !
50    ! This program is designed to run on an external
60    ! controller.  It demonstrates how the external
70    ! controller and HP IBASIC can work together.  The
80    ! program downloads an IBASIC program to the HP 871X
90    ! and runs it twice.  After each run, two program
100   ! variables are read from the analyzer and displayed.
110   !
120   !-----------------------------------------------------
130   !
140   ! Initialize the variables for the interface select
150   ! code and the HP-IB address of the HP 871X.
160   !
170   Scode=7
180   Address=16
190   Na=Scode*100+Address
200   !
210   ! Prepare the analyzer for remote operation, clear
220   ! the analyzer's input/output queues, the display
230   ! and scratch any program in the buffer.
240   !
250   CLEAR Na
260   CLEAR SCREEN
270   OUTPUT Na;"PROG:DEL:ALL"
280   !
290   !  Download the program as an indefinite block length
300   !  data transfer, terminate the data transfer by
310   !  sending a carriage return and EOI.
320   !
330   DISP "Downloading the program..."
340   ASSIGN @Prog TO Na
350   OUTPUT @Prog;"PROG:DEF #0";
360   OUTPUT @Prog;"10 COM INTEGER Times_run,Test$[10]"
370   OUTPUT @Prog;"20 Times_run=Times_run+1"
380   OUTPUT @Prog;"30 IF Times_run=1 THEN Test$=""PASS"""
390   OUTPUT @Prog;"40 IF Times_run=2 THEN Test$=""FAIL"""
400   OUTPUT @Prog;"50 FOR I= 1 TO 20"
410   OUTPUT @Prog;"60 BEEP"
420   OUTPUT @Prog;"70 NEXT I"
430   OUTPUT @Prog;"80 END"
440   OUTPUT @Prog;CHR$(10) END
450   !
460   ! Initialize interrupt registers - clear the status byte,
470   ! the service request enable register, the standard event
480   ! enable register, and preset the other status registers.
490   !
```

```
500   OUTPUT Na;"*CLS"
510   OUTPUT Na;"*SRE 0"
520   OUTPUT Na;"*ESE 0"
530   OUTPUT Na;"STAT:PRES"
540   !
550   ! Set up the status registers to generate an interrupt
560   ! on negative transition of the Program Running bit
570   ! (bit 14 in the Operational Status register).
580   !
590   OUTPUT Na;"STAT:OPER:NTR #HFFFF"
600   OUTPUT Na;"STAT:OPER:ENAB 16384"
610   OUTPUT Na;"*CLS"
620   OUTPUT Na;"*SRE 128"
630   !
640   ! Run the program, read and display the variables.
650   !
660   DISP "Running the program..."
670   OUTPUT Na;"PROG:EXEC 'RUN'"
680   Display_res(Na,Scode)
690   OUTPUT Na;"PROG:EXEC 'RUN'"
700   Display_res(Na,Scode)
710   !
720   ! Return the analyzer to front panel control, this
730   ! is the end of the program.
740   !
750   LOCAL Na
760   DISP "DONE !"
770   END
780   !
790   !-----------------------------------------------------
800   !
810   SUB Display_res(Na,Scode)
820     !---------------------------------------------------
830     !
840     ! This subprogram waits for an SRQ interrupt to
850     ! signal that an IBASIC program running on the
860     ! analyzer has finished.  It then reads and clears
870     ! the HP-IB status registers.  The values of two
880     ! program variables are then read and displayed.
890     !
900     !---------------------------------------------------
910     !
920     ! Setup branching to an interrupt handling routine,
930     ! enable the interrupts and wait until one occurs.
940     !
950     ON INTR Scode GOTO Read_results
960     ENABLE INTR Scode;2
970 Idle: GOTO Idle
980 Read_results: !
990     !
1000    ! The program has finished running - read and clear
```

```
1010    ! the operational status register and status byte.
1020    !
1030    A=SPOLL(Na)
1040    OUTPUT Na;"STAT:OPER:EVEN?"
1050    ENTER Na;Event
1060    OUTPUT Na;"*CLS"
1070    !
1080    ! Read a numeric variable (Times_run) and a string
1090    ! variable (Test$) and display the values.
1100    !
1110    OUTPUT Na;"PROG:NUMB? 'Times_run'"
1120    ENTER Na USING "X,K";Times_run
1130    OUTPUT Na;"PROG:STR? 'Test$'"
1140    ENTER Na USING "X,K";Test$
1150    DISP "Times_run: ";Times_run,"Test$: ";Test$
1160    PRINT "Times_run: ";Times_run,"Test$: ";Test$
1170  SUBEND
```

REPORT — Using the parallel port

```
10    !-----------------------------------------------------
20    !
30    ! IBASIC program:  REPORT - Using the parallel port
40    !
50    ! This program uses the 871X to generate a report,
60    ! making a hardcopy on a printer connected to the
70    ! parallel port.  It uses a subprogram to send the
80    ! output to the parallel port one line at a time.
90    !
100   ! This example uses five different font types that
110   ! may or may not be supported for your printer.
120   ! These character fonts are available for HP LaserJet
130   ! printers.  Refer to your printer manual to modify
140   ! the example fonts for your printer.
150   !
160   !-----------------------------------------------------
170   !
180   ! Assign an I/O path name for the internal bus and
190   ! declare and initialize variables.
200   !
210   COM /Cset/Block$[50],Title$[50],Slant$[50],Banner$[50],Medium
$[50]
220   ASSIGN @Rfna TO 800
230   Esc$=CHR$(27)
240   !
250   ! Preset the analyzer, put it in Trigger HOLD mode,
260   ! allocate the full IBASIC display and clear the
270   ! screen.
280   !
290   OUTPUT @Rfna;"SYST:PRES;*WAI"
300   OUTPUT @Rfna;"ABOR;:INIT:CONT OFF;*WAI"
310   OUTPUT @Rfna;"DISP:PROG FULL"
320   CLEAR SCREEN
330   !
340   ! Define the escape sequence for each font that is
350   ! used.  Refer to your printer manual.
360   !
370   Block$=Esc$&"&l0O"&Esc$&"(8U"&Esc$&"(s1p10h12v0s0b0T"
380   Title$=Esc$&"&l0O"&Esc$&"(8U"&Esc$&"(s1p8h12v0s0b0T"
390   Slant$=Esc$&"&l0O"&Esc$&"(7J"&Esc$&"(s0p6h14v1s0b0T"
400   Banner$=Esc$&"&l0O"&Esc$&"(7J"&Esc$&"(s0p4h24v0s0b0T"
410   Medium$=Esc$&"&l0O"&Esc$&"(7J"&Esc$&"(s0p8h14v0s0b0T"
420   !
430   ! Select the font to use writing the company name
440   ! and address, send the company name and address.
450   !
460   CALL Send_line(Title$,1)
470   CALL Send_line("COMPANY NAME",1)
480   CALL Send_line("CITY, STATE, COUNTRY",1)
```

```
490   CALL Send_line(" ",1)
500   !
510   ! Select the font to use writing the device name,
520   ! send the device name.
530   !
540   CALL Send_line(Banner$,1)
550   CALL Send_line(" _",0)
560   CALL Send_line(" _",1)
570   CALL Send_line(" ",1)
580   CALL Send_line(" ",1)
590   CALL Send_line("  BPF-175 Bandpass Filter",1)
600   CALL Send_line(" ",1)
610   CALL Send_line(" ",1)
620   CALL Send_line(" _",0)
630   CALL Send_line(" _",1)
640   CALL Send_line("  ",1)
650   !
660   ! Select the font to use writing the device
670   ! specifications, send the information.
680   !
690   CALL Send_line(Slant$,1)
700   CALL Send_line("  ",1)
710   CALL Send_line("PASS BAND (MHZ)        3 dB
60 +/- 5",1)
720   CALL Send_line(" ",1)
730   CALL Send_line("                      20 dB
90 +/- 5",1)
740   CALL Send_line(" ",1)
750   CALL Send_line("                      40 dB
120 +/- 5",1)
760   CALL Send_line(" ",1)
770   CALL Send_line("SWR PASSBAND (typical)     1.8:1",1)
780   CALL Send_line(" ",1)
790   CALL Send_line("SWR STOPBAND (typical)     1.8:1",1)
800   CALL Send_line(" ",1)
810   CALL Send_line("Cost per unit:            36.95",1)
820   !
830   ! Select the font to use for the performance data
840   ! title, send the title.
850   !
860   CALL Send_line(Block$,1)
870   CALL Send_line("                              ",0)
880   CALL Send_line("                  Transmission  Characterist
ics",1)
890   !
900   ! Return the display to the analyzer.
910   !
920   OUTPUT @Rfna;"DISP:PROG OFF"
930   !
940   ! Setup the device measurement.  This example
950   ! measures the transmission response of a
```

```
960   ! bandpass filter at 175 MHz.
970   !
980   OUTPUT @Rfna;"DISP:ANN:FREQ1:MODE SSTOP"
990   OUTPUT @Rfna;"SENS1:FREQ:STAR 10 MHz;STOP 400 MHz;*WAI"
1000  OUTPUT @Rfna;"DISP:WIND1:TRAC:Y:PDIV 20 dB;RLEV -50 dB;RPOS 5
"
1010  OUTPUT @Rfna;"DISP:ANN:TITL ON;TITL1:DATA 'HP 8711 RF NETWORK
ANALYZER'"
1020  !
1030  ! Take a measurement sweep and wait for it to
1040  ! complete.  Perform a -3 dB bandwidth search.
1050  !
1060  OUTPUT @Rfna;"INIT1;*OPC?"
1070  ENTER @Rfna;Opc
1080  OUTPUT @Rfna;"CALC1:MARK1 ON;MARK:BWID -3"
1090  !
1100  ! Select the parallel port and the printer's
1110  ! control language as the hardcopy device.
1120  ! Set the printer resolution and margins -
1130  ! turn off automatic form feed.
1140  !
1150  OUTPUT @Rfna;"HCOP:DEV:LANG PCL;PORT CENT"
1160  OUTPUT @Rfna;"HCOP:DEV:RES 300"
1170  OUTPUT @Rfna;"HCOP:PAGE:MARG:LEFT  40"
1180  OUTPUT @Rfna;"HCOP:PAGE:WIDT  110"
1190  OUTPUT @Rfna;"HCOP:ITEM1:FFE:STAT OFF"
1200  !
1210  ! Send the measurement data (graph and marker
1220  ! values) to the printer.
1230  !
1240  OUTPUT @Rfna;"HCOP"
1250  !
1260  ! Select the fonts and send the "footer"
1270  ! information for the report.
1280  !
1290  CALL Send_line(Banner$,1)
1300  CALL Send_line(" ",1)
1310  CALL Send_line(" ",1)
1320  CALL Send_line("IN STOCK  IMMEDIATE DELIVERY!",1)
1330  CALL Send_line(Medium$,1)
1340  CALL Send_line("         ",0)
1350  CALL Send_line("For more information: Call 1-800-Filter",1)
1360  !
1370  ! Send a form feed to the printer.
1380  !
1390  WRITEIO 15,0;12
1400  END
1410  !--------------------------------------------------
1420  SUB Send_line(String$,INTEGER Crlf)
1430    !------------------------------------------------
1440    !
```

```
1450   ! The subprogram sends a string to the parallel port
1460   ! (I/O port 15).  The Crlf flag determines whether
1470   ! a carriage return (ASCII 13) and line feed (ASCII
1480   ! 10) are needed at the end of the string.
1490   !
1500   !---------------------------------------------------
1510   INTEGER Length
1520   Length=LEN(String$)
1530   FOR I=1 TO Length
1540     WRITEIO 15,0;NUM(String$[I;1])
1550   NEXT I
1560   IF Crlf=1 THEN
1570     WRITEIO 15,0;10
1580     WRITEIO 15,0;13
1590   END IF
1600 SUBEND
```

TRICTRL — External controller with local IBASIC controllers

```
10   !-----------------------------------------------------------
20   !
30   ! BASIC program:  TRICTRL - Three controller operation
40   !   One controller, Two IBASIC instruments
50   !
60   ! This program is designed to run on an external
70   ! controller.  It demonstrates how the external
80   ! controller and multiple instruments running IBASIC
90   ! programs can be synchronized to work together.
100  !
110  ! Run this program on an external controller. Two HP871x
120  ! are needed.  Set one HP871x to address 16.  Set the
130  ! other to address 18.  Connect HP-IB cables between
140  ! the controller and the two analyzers.
150  !
160  ! The program downloads IBASIC programs to two HP 871Xs,
170  ! then runs each program.  Pressing softkey 1 on either
180  ! instrument triggers a sweep.  Pressing softkey 3 on
190  ! either instrument will trigger an SRQ.  The controller
200  ! will poll the instrument over the HP-IB bus, determine
210  ! which inetrument has requested service, log the SRQ,
220  ! and releaee the instrument for more measuremente by
230  ! setting the IBASIC variable Ctrl_flag.
240  !-----------------------------------------------------------
250  !
260  ! Initialize the variables for the interface select
270  ! code and the HP-IB address of the HP 871X.
280  !
290   Scode=7
300   Address1=16
310   Address2=18
320   Na1=Scode*100+Address1
330   Na2=Scode*100+Addrees2
340   Dev_count1=0
350   Dev_count2=0
360  !
370  ! Prepare the analyzer for remote operation, clear
380  ! the analyzer's input/output queues and scratch
390  ! any program in the buffer.
400  !
410   ABORT 7
420   CLEAR Na1
430   CLEAR Na2
440   CLEAR SCREEN
450  !
460   OUTPUT Na1;"SYST:PRES;*OPC?"          ! Preset analyzer #1
470   ENTER Na1;Opc
480   OUTPUT Na2;"SYST:PRES;*OPC?"          ! Preset analyzer #2
490   ENTER Na2;Opc
```

```
500  !
510   OUTPUT Na1;"PROG:STAT STOP"            ! Stop all programs
520   REMOTE Na1
530   OUTPUT Na1;"PROG:DEL:ALL"              ! Scratch the programs
540   OUTPUT Na2;"PROG:STAT STOP"
550   REMOTE Na2
560   OUTPUT Na2;"PROG:DEL:ALL"
570  !
580  ! Initialize interrupt registers - clear the status byte,
590  ! the service request enable register, the standard event
600  ! enable register, and preset the other status registers.
610  !
620   OUTPUT Na1;"*CLS"
630   OUTPUT Na1;"*SRE 0"
640   OUTPUT Na1;"*ESE 0"
650   OUTPUT Na1;"STAT:PRES;*OPC?"
660   ENTER Na1;Opc
670  !
680   OUTPUT Na2;"*CLS"
690   OUTPUT Na2;"*SRE 0"
700   OUTPUT Na2;"*ESE 0"
710   OUTPUT Na2;"STAT:PRES;*OPC?"
720   ENTER Na2;Opc
730  !
740   ON INTR 7,2 GOSUB User_srq        ! Define the SRQ service ro
utine
750   GOSUB Usermask                    ! Enable the user SRQ
760   ENABLE INTR 7;2
770  !
780  !  Download the program as an indefinite block length
790  !  data transfer, terminate the data transfer by
800  !  sending a carriage return and EOI.
810  !
820   DISP "Downloading the programs..."
830   ASSIGN @Prog TO Na1
840   GOSUB Dnld
850   ASSIGN @Prog TO Na2
860   GOSUB Dnld
870  !
880  ! Run the programs
890   DISP "Running the programs..."
900   OUTPUT Na1;"PROG:STAT RUN;*OPC?"
910   ENTER Na1;Opc
920  !
930   OUTPUT Na2;"PROG:STAT RUN;*OPC?"
940   ENTER Na2;Opc
950  !
960   BEEP
970   DISP "Waiting for srq..."
980  !
990   LOCAL Na1
```

```
1000  LOCAL Na2
1010 Idle:GOTO Idle
1020  STOP
1030 ! Enable SRQs to occur when the user_srq bit is set
1040 Usermask:         !
1050  OUTPUT Na1;"*ESE 64;*SRE 32"
1060  OUTPUT Na1;"*OPC?"
1070  ENTER Na1;Opc
1080  OUTPUT Na2;"*ESE 64;*SRE 32"
1090  OUTPUT Na2;"*OPC?"
1100  ENTER Na2;Opc
1110  RETURN
1120 !
1130 User_srq:     ! This routine is called to service SRQs
1140  Stb=SPOLL(Na1)        ! Poll the first instrument
1150  IF (BINAND(Stb,64)0) THEN
1160    OUTPUT Na1;"*ESR?"
1170    ENTER Na1;Stat
1180    Dev_count1=Dev_count1+1
1190    PRINT "Inst:",Na1,"Dev:",Dev_count1
1200    OUTPUT Na1;"PROG:NUMB 'Ctlr_flag',0"  ! Clear the IBASIC f
lag
1210    LOCAL Na1
1220  ELSE
1230 !
1240    Stb=SPOLL(Na2)      ! Poll the second instrument
1250    IF (BINAND(Stb,64)0) THEN
1260      OUTPUT Na2;"*ESR?"
1270      ENTER Na2;Stat
1280      Dev_count2=Dev_count2+1
1290      PRINT "Inst:",Na2,"Dev:",Dev_count2
1300      OUTPUT Na2;"PROG:NUMB 'Ctlr_flag',0"  ! Clear the IBASIC
 flag
1310      LOCAL Na2
1320    END IF
1330  END IF
1340 !
1350  ENABLE INTR 7
1360  RETURN
1370 !
1380 Dnld: ! Download example program to analyzer
1390  OUTPUT @Prog;"PROG:DEF #0";
1400  OUTPUT @Prog;"10 COM INTEGER Ctlr_flag"
1410  OUTPUT @Prog;"20 OUTPUT 800;""ABOR;:INIT1:CONT OFF"""
1420  OUTPUT @Prog;"30 ON KEY 1 LABEL ""Test 1"" GOSUB Do_test"
1430  OUTPUT @Prog;"40 ON KEY 3 LABEL ""Done Test"" GOSUB Send_srq"
1440  OUTPUT @Prog;"50 Idle:GOTO Idle"
1450  OUTPUT @Prog;"60 STOP"
1460  OUTPUT @Prog;"70 Send_srq: !"
1470  OUTPUT @Prog;"80 BEEP"
1480  OUTPUT @Prog;"90 Ctlr_flag=1"
```

```
1490  OUTPUT @Prog;"100 OUTPUT 800;""SYST:KEY:USER"""
1500  OUTPUT @Prog;"110 DISP ""Waiting for CTLR..."""
1510  OUTPUT @Prog;"120 Stall: IF Ctlr_flag=1 THEN GOTO Stall"
1520  OUTPUT @Prog;"130 DISP "" """
1530  OUTPUT @Prog;"140 RETURN"
1540  OUTPUT @Prog;"150 DO_TEST: OUTPUT 800;""INIT1;*OPC?"""
1550  OUTPUT @Prog;"160 ENTER 800;Opc"
1560  OUTPUT @Prog;"170 RETURN"
1570  OUTPUT @Prog;"180 END"
1580  OUTPUT @Prog;CHR$(10) END
1590  OUTPUT @Prog;"*opc?"
1600  ENTER @Prog;Opc
1610  RETURN
1620  END
1630 !
```

UPLOAD — Upload program from analyzer

```
10   !-----------------------------------------------------
20   !
30   ! BASIC program: UPLOAD - Upload program from HP 871X
40   !
50   ! This program uploads the current IBASIC program
60   ! in the HP 871X's program buffer to an ASCII file
70   ! on the controller's current mass storage device.
80   !
90   !-----------------------------------------------------
100  !
110  ! Assign an I/O path name to the HP 8711, initialize
120  ! the variables, and clear the analyzer's input/output
130  ! queues.
140  !
150   ASSIGN @Rfna TO 716
160   DIM Prog_line$[256]
170   CLEAR @Rfna
180  !
190  ! Enter the name of the file to be created.
200  !
210   INPUT "ENTER NAME OF FILE TO UPLOAD PROGRAM TO ",Filename$
220   PRINT Filename$
230  !
240  ! Query the HP 8711 for the contents of its
250  ! program buffer.
260  !
270   OUTPUT @Rfna;"PROG:DEF?"
280  !
290  ! Read the block header, the number of digits in
300  ! the file size, and the file size.
310  !
320   ENTER @Rfna USING "#,A,D";Prog_line$,Ndigits
330   ENTER @Rfna USING "#,"&VAL$(Ndigits)&"D";Nbytes
340  !
350  ! Create the target ASCII file on the current mass
360  ! storage device and assign it an I/O path name.
370  !
380   Openfile(@File,Filename$,Nbytes)
390   ASSIGN @File TO Filename$;FORMAT ON
400  !
410  ! Read the program one line at a time, and write
420  ! it to the new file.  Print each line on the
430  ! display as it is read.
440  !
450   LOOP
460     ENTER @Rfna;Prog_line$
470   EXIT IF LEN(Prog_line$)=0
480     PRINT Prog_line$
490     OUTPUT @File;Prog_line$
```

```
500   END LOOP
510  !
520  ! Close the new file.
530  !
540   ASSIGN @File TO *
550   END
560  !-------------------------------------------------------
570   SUB Openfile(@File,Filename$,Fsize)
580  !-----------------------------------------------------
590  !
600  ! This subprogram creates an ASCII file with the
610  ! name 'Filename$' of the specified size 'Fsize'.
620  ! Error trapping is used to detect any errors in
630  ! opening the file.  If the controller is HP IBASIC
640  ! for Windows a DOS file is created, otherwise the
650  ! LIF format is used.
660  !
670  !-----------------------------------------------------
680     ON ERROR GOTO Openerr
690     IF SYSTEM$("SYSTEM ID")="IBASIC/WINDOWS" THEN
700       CREATE Filename$,1
710     ELSE
720       IF Fsize MOD 256>0 THEN Fsize=Fsize+256
730       CREATE ASCII Filename$,Fsize DIV 256
740     END IF
750  !
760 Openerr:IF ERRN54 THEN PRINT ERRM$
770   SUBEND
```

USERBEG — Set up user-defined User BEGIN softkeys

```
10 !Filename:  USERBEGIN
20 !
70    !
80    ! Description:  Program to set up the User Begin softkeys.
90    !
100   !  A) This program creates User Begin softkeys which allow
110   !      the user to:  Save or Recall one of two instrument
120   !      states, set the marker to maximum, set the scale/div,
130   !      and compute some measurement statistics at the marker.
140   !
150   !  B) In order to run this program, do the following -
160   !    1) Load this program into the 871x
170   !    2) Press the "BEGIN" (hardkey) and the "User Begin
on/OFF" (softkey).
180   !    3) The "User Begin" function is now enabled (which runs
this
190   !      program).  This program re-defines the softkeys
displayed
200   !      whenever the BEGIN hardkey is pressed.  The functions
210   !      performed by these softkeys are defined by this
220   !      program.  Note that all front panel keys in the
analyzer are
230   !      active (as if there were no program running).
240   !    4) Use the instrument as you normally would.  However,
when
250   !      the BEGIN hardkey is pressed, the menu defined
260   !      by this program will be displayed instead of the usual
270   !      BEGIN softkeys, until the "User Begin ON/off" (softkey
)
280   !      is pressed, turning off the "User Begin" mode.
290   !
300   !*******************************************************
310   ! Initialize
320   !
330 User_begin:ASSIGN @Hp871x TO 800    !REQUIRED - first line for
User Begin program
340   !
350   REAL Vert_scale,Mrkr_data(1:30),Mrkr_mean,Mrkr_sdev
360   REAL Mrkr_max,Mrkr_min,I
370   DIM Message$[124]
380   !
390   !-------------------------------------------------------
400   ! Write the softkey labels.  Maximum label length=20character
s
410   !
420   OUTPUT @Hp871x;"DISP:MENU2:KEY8 '';*WAI"     !clear all label
s
430   OUTPUT @Hp871x;"DISP:MENU2:KEY1 '      Save   State 1';*WAI"
440   OUTPUT @Hp871x;"DISP:MENU2:KEY2 '    Recall   State 1';*WAI"
```

```
450   OUTPUT @Hp871x;"DISP:MENU2:KEY3 '      Save   State 2';*WAI"
460   OUTPUT @Hp871x;"DISP:MENU2:KEY4 '    Recall   State 2';*WAI"
470   OUTPUT @Hp871x;"DISP:MENU2:KEY5 'Mkr -> Max';*WAI"
480   OUTPUT @Hp871x;"DISP:MENU2:KEY6 'Scale/Div';*WAI"
490   OUTPUT @Hp871x;"DISP:MENU2:KEY7 '    MarkerStatistics';*WAI"
500   !
510 User_pause:PAUSE    !pause the program until a softkey is press
ed
520   GOTO User_pause   !return to program pause after a softkey p
ress
530   !
540   !--------------------------------------------------------
550   ! Define softkey routines
560   !
570 User_key1:            ! Define softkey 1:  save state 1
580   OUTPUT @Hp871x;"MMEM:STOR:STAT 1,'MEM:UBEGN1.STA'"  !save sta
te 1
590   GOTO User_pause    !return to softkey loop
600   !
610 User_key2:            ! Define softkey 2:  recall state 1
620   OUTPUT @Hp871x;"MMEM:LOAD:STAT 1,'MEM:UBEGN1.STA'"  !recall s
tate 1
630   GOTO User_pause    !return to softkey loop
640   !
650 User_key3:            ! Define softkey 3:  save state 2
660   OUTPUT @Hp871x;"MMEM:STOR:STAT 1,'MEM:UBEGN2.STA'"  !save sta
te 2
670   GOTO User_pause    !return to softkey loop
680   !
690 User_key4:            ! Define softkey 4:  recall state 2
700   OUTPUT @Hp871x;"MMEM:LOAD:STAT 1,'MEM:UBEGN2.STA'"  !recall
state 2
710   GOTO User_pause    !return to softkey loop
720   !
730 User_key5:      ! Define softkey 5:  set marker to max
740   OUTPUT @Hp871x;"CALC1:MARK:FUNC MAX"      !marker -> max
750   GOTO User_pause
760   !
770 User_key6:      ! Define softkey 6:  adjust the scale, dB/Div,
of the trace
780   INPUT "Enter the scale (dB/Div)",Vert_scale  !ask user for sc
ale
790   OUTPUT @Hp871x;"DISP:WIND1:TRAC:Y:PDIV "&VAL$(Vert_scale) !s
et the scale
800   GOTO User_pause
810   !
820 User_key7:      ! Define softkey 7:  compute statistics for mar
ker.
830   OUTPUT @Hp871x;"DISP:ANN:MESS:DATA 'Computing marker statisti
cs...'"
840   OUTPUT @Hp871x;"CALC1:MARK1 ON"       !ensure marker is on
```

```
850   FOR I=1 TO 30                          !read marker 30 times
860     OUTPUT @Hp871x;"CALC1:MARK1:Y?"      !get marker reading
870     ENTER @Hp871x;Mrkr_data(I)
880   NEXT I
890   Mrkr_mean=SUM(Mrkr_data)/30            !compute mean
900   !
910   Mrkr_sdev=0                            !initialize standard d
eviation
920   Mrkr_min=Mrkr_data(1)                  !initialize min
930   Mrkr_max=Mrkr_data(1)                  !initialze max
940   FOR I=1 TO 30                          !compute std dev, min,
max
950     Mrkr_sdev=Mrkr_sdev+(Mrkr_data(I)-Mrkr_mean)^2  !sum square
s of deviation
960     Mrkr_min=MIN(Mrkr_min,Mrkr_data(I))             !find min
970     Mrkr_max=MAX(Mrkr_max,Mrkr_data(I))             !find max
980   NEXT I
990   Mrkr_sdev=SQRT(Mrkr_sdev/29)           !finish computation of
std dev
1000  !
1010  Message$="Marker Statistics:"&CHR$(10)            !1st line
of message
1020  Message$=Message$&"  Mean ="&VAL$(Mrkr_mean)&CHR$(10) !2nd
line of message
1030  Message$=Message$&"  Min ="&VAL$(Mrkr_min)&CHR$(10)   !3rd
line of message
1040  Message$=Message$&"  Max ="&VAL$(Mrkr_max)&CHR$(10)   !4th
line of message
1050  Message$=Message$&"  Standard Deviation = "&VAL$(Mrkr_sdev)
!5th line of message
1060  OUTPUT @Hp871x;"DISP:ANN:MESS:DATA '"&Message$&"', MEDIUM"
!display message
1070  GOTO User_pause                        !return to softkey loop
1080  !
1090  END
```

USERBEG1 — The default User BEGIN program

```
10    ! -----------------------------------------------------------
20    !
30    ! BASIC program: USRBEG1
40    !
50    ! This is the default User Defined BEGIN program.  This progr
am
60    ! will automatically install if the [User BEGIN] key is
70    ! selected, and a progam has not been previously loaded.
80    !
90    ! The following line is required. DO NOT REMOVE!
100 User_begin:ASSIGN @Rfna TO 800    ![User Begin] Program
110   !
120   ! To Modify:
130   ! Use [IBASIC][EDIT] or [IBASIC][Key Record]
140   !
150   !
160   ! Delclare storage for variables.
170   DIM Name$[60],Str1$[60],Str2$[60],Str3$[60]
180   !
190   ! Clear the softkey labels
200   OUTPUT @Rfna;"DISP:MENU2:KEY8 '';*WAI"
210   !
220   ! Re-define softkey labels here.
230   OUTPUT @Rfna;"DISP:MENU2:KEY1 '*';*WAI"
240   OUTPUT @Rfna;"DISP:MENU2:KEY2 '*';*WAI"
250   OUTPUT @Rfna;"DISP:MENU2:KEY3 'Mkr -> Max';*WAI"
260   OUTPUT @Rfna;"DISP:MENU2:KEY4 'Title and Clock';*WAI"
270   OUTPUT @Rfna;"DISP:MENU2:KEY5 '*';*WAI"
280   OUTPUT @Rfna;"DISP:MENU2:KEY6 '*';*WAI"
290   OUTPUT @Rfna;"DISP:MENU2:KEY7 '*';*WAI"
300   !
310   !The following 2 lines are required. DO NOT REMOVE!
320 User_pause:PAUSE
330   GOTO User_pause
340   !
350 User_key1:      ! Define softkey 1 here.
360   GOSUB Message ! Remove this line.
370   GOTO User_pause
380   !
390 User_key2:      ! Define softkey 2 here.
400   GOSUB Message ! Remove this line
410   GOTO User_pause
420   !
430 User_key3:      ! Example Marker Function
440   OUTPUT @Rfna;"CALC1:MARK1 ON"
450   OUTPUT @Rfna;"CALC1:MARK:FUNC MAX"
460   GOTO User_pause
470   !
480 User_key4:      ! Example Title Entry
```

```
490   INPUT "Enter Title Line 1.  Press [Enter] when done.",Name$
500   OUTPUT @Rfna;"DISP:ANN:TITL1:DATA '"&Name$&"'"
510   OUTPUT @Rfna;"DISP:ANN:TITL ON"
520   GOTO User_pause
530   !
540 User_key5:       ! Define softkey 5 here.
550   GOSUB Message ! Remove this line.
560   GOTO User_pause
570   !
580 User_key6:       ! Define softkey 6 here.
590   GOSUB Message ! Remove this line.
600   GOTO User_pause
610   !
620 User_key7:       ! Define softkey 7 here.
630   GOSUB Message ! Remove this line.
640   GOTO User_pause
650   !
660 Message:    !
670   Str1$="This key is programmable."
680   Str2$="To modify, select"
690   Str3$="[System Options], [IBASIC], [Edit]."
700   OUTPUT @Rfna;"DISP:ANN:MESS '"&Str1$&CHR$(10)&Str2$&CHR$(
10)&Str3$&"', MEDIUM"
710   RETURN
720   !
730   END
```

USERBEG2 — Fast recall of instrument states

```
10    ! ------------------------------------------------------------
20    !
30    ! BASIC program: USRBEG2
40    !
50    ! This is an example User Defined BEGIN program.  This progra
m
60    ! will recall the named file.  Demonstrates fast recall
70    ! of a previously defined files SETUP1, SETUP2, and SETUP3.
80    !
90    ! The following line is required. DO NOT REMOVE!
100 User_begin:ASSIGN @Rfna TO 800    ![User Begin] Program
110   !
120   ! To Modify:
130   ! Use [IBASIC][EDIT] or [IBASIC][Key Record]
140   !
150   !
160   ! Delclare storage for variables.
170   DIM Name$[60],Str1$[60],Str2$[60],Str3$[60]
180   !
190   ! Clear the softkey labels
200   OUTPUT @Rfna;"DISP:MENU2:KEY8 '';*WAI"
210   !
220   ! Re-define softkey labels here.
230   OUTPUT @Rfna;"DISP:MENU2:KEY1 'Setup1';*WAI"
240   OUTPUT @Rfna;"DISP:MENU2:KEY2 'Setup2';*WAI"
250   OUTPUT @Rfna;"DISP:MENU2:KEY3 'Setup3';*WAI"
260   OUTPUT @Rfna;"DISP:MENU2:KEY4 '*';*WAI"
270   OUTPUT @Rfna;"DISP:MENU2:KEY5 '*';*WAI"
280   OUTPUT @Rfna;"DISP:MENU2:KEY6 '*';*WAI"
290   OUTPUT @Rfna;"DISP:MENU2:KEY7 '*';*WAI"
300   !
310   !The following 2 lines are required. DO NOT REMOVE!
320 User_pause:PAUSE
330   GOTO User_pause
340   !
350 User_key1:      ! Define softkey 1 here.
360   OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:SETUP1'"
370   GOTO User_pause
380   !
390 User_key2:      ! Define softkey 2 here.
400   OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:SETUP2'"
410   GOTO User_pause
420   !
430 User_key3:      ! Example Marker Function
440   OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:SETUP3'"
450   GOTO User_pause
460   !
470 User_key4:      ! Example Title Entry
480   GOTO User_pause
```

```
490   !
500 User_key5:      ! Define softkey 5 here.
510   GOTO User_pause
520   !
530 User_key6:      ! Define softkey 6 here.
540   GOTO User_pause
550   !
560 User_key7:      ! Define softkey 7 here.
570   GOTO User_pause
580   !
590   END
```

USER_BIT — Using the USER bit

```
10    !-----------------------------------------------------
20    !
30    ! IBASIC program:  USER_BIT - Using the USER bit
40    !
50    ! This program reads and writes to the USER bit.
60    ! IBASIC's graphics commands are used to draw the
70    ! USER bit value to the display.
80    !
90    !-----------------------------------------------------
100   !
110   ! Assign an I/O path name to the internal bus and
120   ! initialize variables.
130   !
140   ASSIGN @Rfna TO 800
150   INTEGER Beeper,Count
160   Count=0
170   Beeper=0
180   !
190   ! Preset the analyzer, setup measurement and display
200   ! parameters for a measurement and put the analyzer
210   ! in Trigger HOLD mode.
220   !
230   OUTPUT @Rfna;"SYST:PRES;*WAI"
240   OUTPUT @Rfna;"DISP:ANN:FREQ1:MODE SSTOP"
250   OUTPUT @Rfna;"SENS1:FREQ:STAR 100 MHz;STOP 400 MHz;*WAI"
260   OUTPUT @Rfna;"DISP:WIND1:TRAC:Y:PDIV 20 dB;RLEV -60 dB;RPOS 5
"
270   OUTPUT @Rfna;"SENS1:SWE:POIN 101;TIME .1 s;*WAI"
280   OUTPUT @Rfna;"ABOR;:INIT1:CONT OFF;*WAI"
290   !
300   ! Wait for all the setup operations to be complete
310   ! before continuing the program.
320   !
330   OUTPUT @Rfna;"*OPC?"
340   ENTER @Rfna;Opc
350   !
360   ! Allocate the lower display partition.
370   !
380   OUTPUT @Rfna;"DISP:PROG LOW"
390   !
400   ! Setup a softkey menu to enable and disable the
410   ! beeper.  Clear the analyzer's input/output queues.
420   !
430   ON KEY 1 LABEL "Beep      Enable" GOSUB Beep_on
440   ON KEY 2 LABEL "Beep      Disable" GOSUB Beep_off
450   CLEAR @Rfna
460   !
470   ! Trigger 100 sweeps.  Beep (if the beeper flag is set)
480   ! and toggle the USER bit after each sweep.
```

```
490   !
500   DISP "USER bit example program. End of sweep toggles USER bit."
510   PRINT "Draw the end of sweep USER bit value..."
520   MOVE 0,50
530   FOR I=1 TO 100
540     OUTPUT @Rfna;"INIT1;*OPC?"
550     ENTER @Rfna;Opc
560     GOSUB Toggle
570   NEXT I
580   DISP "End program"
590   STOP
600   !
610   ! The Odd flag's value alternates between 1 and 0
620   ! depending on the number of sweeps that have been
630   ! taken.  It is the value that is written to the
640   ! USER bit.
650   !
660 Toggle: !
670   IF Odd=0 THEN
680     WRITEIO 15,1;0
690     Odd=1
700   ELSE
710     WRITEIO 15,1;1
720     Odd=0
730   END IF
740   IF Beeper=1 THEN
750     BEEP
760   END IF
770   !
780   ! Read the value of the USER bit and draw it to the
790   ! IBASIC display.
800   !
810   Val=READIO(15,1)
820   Val=Val*30
830   DRAW 8*(I-1),Val+50
840   DRAW 8*I,Val+50
850   RETURN
860   !
870   ! These two subroutines set a flag that is used
880   ! to turn on or off the beeper.
890   !
900 Beep_on: Beeper=1
910   RETURN
920   !
930 Beep_off: Beeper=0
940   RETURN
950   END
```

USERKEYS — Customized softkeys

```
10     !-------------------------------------------------------
20     !
30     ! IBASIC program:  USERKEYS - Customized softkeys
40     !
50     ! This program provides an example template for use
60     ! in customizing the HP 871X's softkeys.  The example
70     ! demonstrates how to set up six instrument states,
80     ! store them to the analyzer's internal memory, and
90     ! setup two interactive softkey menus to choose
100    ! between them.
110    !
120    !-------------------------------------------------------
130    !
140    ! Assign an I/O path name to the internal bus, preset
150    ! the analyzer, wait until the preset is complete,
160    ! turn on Trigger HOLD mode and set the display scale
170    ! and reference values.
180    !
190    ASSIGN @Rfna TO 800
200    OUTPUT @Rfna;"SYST:PRES;*OPC?"
210    ENTER @Rfna;Opc
220    OUTPUT @Rfna;"ABOR;:INIT1:CONT OFF;*WAI"
230    OUTPUT @Rfna;"DISP:WIND1:TRAC:Y:PDIV 20 dB;RLEV -60 dB;RPOS 5
"
240    !
250    ! Setup six instrument states and store them to the
260    ! internal memory.
270    !
280    GOSUB Save_1
290    GOSUB Save_2
300    GOSUB Save_3
310    GOSUB Save_4
320    GOSUB Save_5
330    GOSUB Save_6
340    !
350    ! Setup the Main Menu keys.
360    !
370    GOSUB Menu_1
380    !
390    ! Wait until a softkey is pressed.
400    !
410 Suspend: !
420    WAIT 100000
430    GOTO Suspend
440    STOP
450    !
460    ! This subroutine sets up the softkey menus -
470    ! Menu1 sets up the main menu, Menu2 sets up
480    ! the second level menu.
```

```
490   !
500 Menu_1: BEEP
510   DISP "MAIN MENU"
520   ON KEY 1 LABEL "Setup #1" GOSUB Load_1
530   ON KEY 2 LABEL "Setup #2" GOSUB Load_2
540   ON KEY 3 LABEL "Setup #3" GOSUB Load_3
550   ON KEY 5 LABEL "Autoscale" GOSUB Autoscale
560   ON KEY 6 LABEL " Next Menu" GOSUB Menu_2
570   RETURN
580   !
590 Menu_2:  BEEP
600   DISP "MORE MENU"
610   ON KEY 1 LABEL "Setup #4" GOSUB Load_4
620   ON KEY 2 LABEL "Setup #5" GOSUB Load_5
630   ON KEY 3 LABEL "Setup #6" GOSUB Load_6
640   ON KEY 5 LABEL "Autoscale" GOSUB Autoscale
650   ON KEY 6 LABEL "Prior Menu" GOSUB Menu_1
660   RETURN
670   !
680   ! This subroutine automatically sets the scale and
690   ! reference values of the display.
700   !
710 Autoscale: OUTPUT @Rfna;"DISP:WIND1:TRAC:Y:AUTO ONCE"
720   OUTPUT @Rfna;"DISP:WIND2:TRAC:Y:AUTO ONCE"
730   RETURN
740   !
750   ! These six subroutines each set up the analyzer to
760   ! make a different measurement and store that setup
770   ! to the instrument's internal memory.
780   !
790 Save_1: OUTPUT @Rfna;"SENS1:STAT ON;*WAI"
800   OUTPUT @Rfna;"DISP:ANN:FREQ1:MODE SSTOP"
810   OUTPUT @Rfna;"SENS1:FREQ:STAR 100 MHz;STOP 400 MHz;*WAI"
820   OUTPUT @Rfna;"INIT1;*WAI"
830   OUTPUT @Rfna;"MMEM:STOR:STAT 1,'MEM:STATE1.STA'"
840   RETURN
850   !
860 Save_2: OUTPUT @Rfna;"SENS2:STAT ON;*WAI"
870   OUTPUT @Rfna;"SENS2:FUNC 'XFR:POW:RAT 1,0';DET NBAN;*WAI"
880   OUTPUT @Rfna;"DISP:ANN:FREQ2:MODE CSPAN"
890   OUTPUT @Rfna;"SENS2:FREQ:CENT 200 MHz;SPAN 300 MHz;*WAI"
900   OUTPUT @Rfna;"INIT2;*WAI"
910   OUTPUT @Rfna;"MMEM:STOR:STAT 1,'MEM:STATE2.STA'"
920   RETURN
930   !
940 Save_3: OUTPUT @Rfna;"CALC2:FORM SWR"
950   OUTPUT @Rfna;"INIT2;*WAI"
960   OUTPUT @Rfna;"MMEM:STOR:STAT 1,'MEM:STATE3.STA'"
970   OUTPUT @Rfna;"CALC2:FORM MLOG"
980   RETURN
990   !
```

```
1000 Save_4:OUTPUT @Rfna;"SENS2:STAT OFF"
1010  OUTPUT @Rfna;"SENS1:SWE:POIN 1601;*WAI"
1020  OUTPUT @Rfna;"INIT1;*WAI"
1030  OUTPUT @Rfna;"MMEM:STOR:STAT 1,'MEM:STATE4.STA'"
1040  RETURN
1050  !
1060 Save_5:OUTPUT @Rfna;"CALC1:MARK:BWID -3;FUNC:TRAC ON"
1070  OUTPUT @Rfna;"INIT1;*WAI"
1080  OUTPUT @Rfna;"MMEM:STOR:STAT 1,'MEM:STATE5.STA'"
1090  RETURN
1100  !
1110 Save_6:OUTPUT @Rfna;"SENS1:BWID 250 Hz;*WAI"
1120  OUTPUT @Rfna;"SENS1:SWE:POIN 101;*WAI"
1130  OUTPUT @Rfna;"INIT1;*WAI"
1140  OUTPUT @Rfna;"MMEM:STOR:STAT 1,'MEM:STATE6.STA'"
1150  RETURN
1160  !
1170  ! These six subroutines each recall one of the
1180  ! measurement setups that were stored earlier.
1190  !
1200 Load_1:DISP "Setup 1"
1210  OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:STATE1.STA';*WAI"
1220  OUTPUT @Rfna;"INIT1;*WAI"
1230  RETURN
1240  !
1250 Load_2:DISP "Setup 2"
1260  OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:STATE2.STA';*WAI"
1270  OUTPUT @Rfna;"INIT2;*WAI"
1280  RETURN
1290  !
1300 Load_3:DISP "Setup 3"
1310  OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:STATE3.STA';*WAI"
1320  OUTPUT @Rfna;"INIT2;*WAI"
1330  RETURN
1340  !
1350 Load_4:DISP "Setup 4"
1360  OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:STATE4.STA';*WAI"
1370  OUTPUT @Rfna;"INIT1;*WAI"
1380  RETURN
1390  !
1400 Load_5:DISP "Setup 5"
1410  OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:STATE5.STA';*WAI"
1420  OUTPUT @Rfna;"INIT1;*WAI"
1430  RETURN
1440  !
1450 Load_6:DISP "Setup 6"
1460  OUTPUT @Rfna;"MMEM:LOAD:STAT 1,'MEM:STATE6.STA';*WAI"
1470  OUTPUT @Rfna;"INIT1;*WAI"
1480  RETURN
1490  END
```

BARCODE — Using Bar Code Reader

```
10    !---------------------------------------------------
20    !
30    ! IBASIC program:  BARCODE - Using barcode reader
40    !
50    ! This HP 8711 IBASIC program was written for a barcode
60    ! reader, but it is not required.  Sets the 8711's
70    ! state depending on model # of DUT being measured.
80    ! Expects to see BARCODE with the following format:
90    ! Model Number (6 char), space, Serial Number (5 char)
100   ! Valid Models:  BPF175, BPF200, SAW134
110   ! REV A.02.00    930615.JVV
120   !
130   ! -------------------------------------------------
140   !
150   COM /Hpib/ @Rfna
160   COM /Scale/ Sc,INTEGER X,Y
170   DIM Name$[50],Stat$[50],Scan$[90],Lim$(1:3,1:5)[30],Test$(0:1
)[4]
180   INTEGER Tab,Fail_flg,G(1:4)
190   !
200 Init:!
210   Test$(0)="PASS"
220   Test$(1)="FAIL"
230   ASSIGN @Rfna TO 800
240   Sc=1       ! Scales the 8711 drawing and DUT
250   X=5        ! Starting X posn of 8711 plot
260   Y=35       !    "     Y  "
270   Tab=38     ! Tab position for text
280   OUTPUT @Rfna;"SYST:PRES;*OPC?"
290   ENTER @Rfna;Opc
300   OUTPUT @Rfna;"DISP:PROG UPP"
310   GINIT
320   GCLEAR
330   GESCAPE 1,3;G(*)
340   WINDOW G(1),G(3),G(2),G(4)
350   OUTPUT @Rfna;"SENS1:STAT OFF;:SENS2:STAT ON"
360   OUTPUT @Rfna;"DISP:WIND2:TRAC:Y:RPOS 9"
370   OUTPUT @Rfna;"ABOR;:INIT:CONT OFF"
380 Setup: !
390   BEEP 500,.1
400   INPUT "Enter Operator's Name:",Name$
410   BEEP 3000,.03
420   INPUT "Enter Station Number:",Stat$
430   BEEP 3000,.03
440   OUTPUT @Rfna;"SYST:DATE?"
450   ENTER @Rfna;Year,Month,Day
460   CALL Draw_na              ! Draw Network Analyzer.
470   Box(670,35,340,130)       ! Draw text box
480   PRINT TABXY(Tab,3);"Oper: ";Name$[1,15]
```

```
490   PRINT TABXY(Tab,4);"Station: ";Stat$[1,11]
500   PRINT TABXY(Tab,5);"Date: ";Year;Month;Day
S10 Meas_dev: !
520   LOOP
530     CALL Draw_dut(1)
S40     CALL Scan_dut(Scan$,Cent$,Span$,Loss$,Lim$(*))
SSO     PRINT TABXY(Tab,7);"Model:  "&Scan$[1,6]
560     PRINT TABXY(Tab,8);"Serial: "&Scan$[8,12]
570     GOSUB Set_stim
S80     DISP "MEASURING THE DEVICE"
590     OUTPUT @Rfna;"ABOR;:INIT2:CONT OFF;:INIT2;*WAI"
600     OUTPUT @Rfna;"CALC2:MARK1 ON;MARK:FUNC MAX"
610     OUTPUT @Rfna;"CALC2:MARK1:Y?"
620     ENTER @Rfna;Loss
630     PRINT TABXY(Tab,9);"Loss (dB): ";Loss
640 Disp_result:   !
650     OUTPUT @Rfna;"STAT:QUES:LIM:COND?"
660     ENTER @Rfna;Fail_flg
670     Fail_flg=BIT(Fail_flg,1)  ! Bit 1 is for ch2
680     IF Fail_flg THEN BEEP 2100,.S
690     Label(Test$(Fail_flg),125,50,24,5,0,1)
700 Continue:  !
710     CALL Draw_dut(0)
720     BEEP 300,.05
730     INPUT "Disconnect DUT. Measure another? (Y/n)",Ans$
740   EXIT IF UPC$(Ans$[1,1])="N"
7S0     Label(Test$(Fail_flg),12S,S0,24,S,0,0)
760   END LOOP
770   OUTPUT @Rfna;"ABOR;:INIT:CONT ON"
780   STOP
790   !
800 Set_stim: ! Set Freqs and Limit lines
810   OUTPUT @Rfna;"DISP:ANN:FREQ:MODE CSPAN"
820   OUTPUT @Rfna;"SENS:FREQ:CENT "&Cent$&" MHZ;SPAN "&Span$&"
MHZ"
830   OUTPUT @Rfna;"DISP:WIND2:TRAC:Y:RLEV
";-PROUND(VAL(Loss$),1);"DB"
840   FOR I=1 TO 3    ! SET LIMIT LINES
850     OUTPUT @Rfna;"CALC2:LIM:SEGM"&VAL$(I)& ":TYPE "&Lim$(I,1
)&";STAT ON"
860     OUTPUT @Rfna;"CALC2:LIM:SEGM"&VAL$(I)& ":FREQ:STAR "&Lim
$(I,2)&" MHZ;STOP "&Lim$(I,3)&" MHZ"
870     OUTPUT @Rfna;"CALC2:LIM:SEGM"&VAL$(I)& ":AMPL:STAR "&Lim
$(I,4)&" ;STOP "&Lim$(I,S)
880   NEXT I
890   OUTPUT @Rfna;"CALC2:LIM:DISP ON;STAT ON"
900   RETURN
910   END
920   ! #########  SUBPROGRAMS  #########
930   !
940 Draw_na:SUB Draw_na
```

```
950      ! This draws HP 8711 at origin X,Y
960     Box(231,50,460,100)    ! Frame
970     Box(231,50,462,102)
980     Box(125,50,180,72)     ! CRT
990     Box(125,50,182,75)
1000    FOR I=19 TO 82 STEP 9  ! Keys
1010      Box(235,I,15,5)
1020    NEXT I
1030    Box(285,88,15,7)       ! BEGIN
1040    Box(375,88,105,12)     ! Drive
1050    Box(375,88,75,4)
1060    Circle(365,60,15)      ! Knob
1070    Circle(300,15,10)      ! Out
1080    Circle(410,15,10)      ! in
1090    Box(15,20,7,10)        ! Switch
1100    Circle(15,33,4)
1110    Label("RF OUT",300,28,8,5,0,1)
1120    Label("RF IN",410,28,8,5,0,1)
1130  SUBEND
1140  !
1150 Draw_dut:SUB Draw_dut(INTEGER Pen)
1160     ! This connects DUT to HP 8711
1170    PEN Pen
1180    Connect(300,15,320,-20,0)
1190    Box(355,-20,70,15)
1200    Connect(410,15,390,-20,0)
1210    PEN 1
1220  SUBEND
1230  !
1240 Scan_dut:SUB Scan_dut(Scan$,Cent$,Span$,Loss$,Lim$(*))
1250    LOOP
1260      Invalid=0
1270      Scan$="BPF175 12345"  ! Default model/serial
1280      BEEP 500,.05
1290      INPUT "Connect and scan the Device.",Scan$  ! SCAN BARCOD
E HERE
1300      IF LEN(Scan$)<12 THEN    !Valid device needs 12 char.
1310        Invalid=1
1320      ELSE
1330        Model$=Scan$[1,6]
1340        SELECT UPC$(TRIM$(Model$))
1350        CASE "BPF175","BPF177"
1360          RESTORE F1
1370        CASE "BPF200"
1380          RESTORE F2
1390        CASE "SAW134"
1400          RESTORE F3
1410        CASE ELSE
1420          Invalid=1
1430        END SELECT
1440      END IF
```

```
1450    EXIT IF NOT Invalid
1460      DISP Scan$;" <<--is INVALID!  Try again."
1470      BEEP 1500,.2
1480      WAIT 1
1490    END LOOP
1500    BEEP 3000,.03
1510    READ Cent$,Span$,Loss$,Lim$(*)
1520     ! Limit lines format: Center, Span, Loss, (LIM TYPE, STRT,
 STP, STRTdB, STPdB)
1530 F1:DATA 175,250,2    ! 175 MHz BPF
1540    DATA  "LMIN", 160,190,-5,-5
1550    DATA  "LMAX", 100,140,-50,-9
1560    DATA  "LMAX", 210,240,-7,-30
1570 F2:DATA 200,100,1    ! 200 MHz BPF
1580    DATA  "LMIN", 196,204,-3,-3
1590    DATA  "LMAX", 180,190,-40,-10
1600    DATA  "LMAX", 210,220,-10,-40
1610 F3:DATA 134,40,22    ! 134 MHz SAW BPF
1620    DATA  "LMIN", 128,140,-27,-27
1630    DATA  "LMAX", 123,125,-65,-30
1640    DATA  "LMAX", 143,145,-30,-65
1650  SUBEND
1660  !
1670 Box:SUB Box(Xpos,Ypos,Xsize,Ysize)
1680    COM /Scale/ Sc,INTEGER X,Y
1690    MOVE X+(Xpos-Xsize/2)*Sc,Y+(Ypos-Ysize/2)*Sc
1700    RECTANGLE Xsize*Sc,Ysize*Sc*1.79 ! 1.79 = 8711 Pixel H:W Ra
tio
1710  SUBEND
1720  !
1730 Circle:SUB Circle(Xpos,Ypos,Radius)
1740    COM /Scale/ Sc,INTEGER X,Y
1750    MOVE X+Xpos*Sc,Y+Ypos*Sc
1760    POLYGON Radius*Sc,16,16
1770  SUBEND
1780  !
1790 Connect:SUB Connect(X1,Y1,X2,Y2,How)
1800    COM /Scale/ Sc,INTEGER X,Y
1810    MOVE X+X1*Sc,Y+Y1*Sc
1820    SELECT How
1830    CASE 1        !...diagonal
1840      DRAW X+X2*Sc,Y+Y2*Sc
1850    CASE 0
1860      DRAW X+X1*Sc,Y+Y2*Sc
1870      DRAW X+X2*Sc,Y+Y2*Sc
1880    CASE -1
1890      DRAW X+X2*Sc,Y+Y1*Sc
1900      DRAW X+X2*Sc,Y+Y2*Sc
1910    END SELECT
1920  SUBEND
1930  !
```

```
1940 Label:SUB Label(Text$,Xpos,Ypos,Size,Lorg,Ldr,Pen)
1950    COM /Scale/ Sc,INTEGER X,Y
1960    LORG Lorg
1970    LDIR Ldr
1980    CSIZE Size*Sc,1
1990    MOVE X+Xpos*Sc,Y+Ypos*Sc
2000    PEN Pen
2010    LABEL Text$
2020    PEN 1
2030  SUBEND
2040  !
2050 Amp:SUB Amp(Xpos,Ypos,Size) ! Draws > Triangle
2060    COM /Scale/ Sc,INTEGER X,Y
2070    MOVE X+(Xpos+Size/2)*Sc,Y+Ypos*Sc
2080    POLYGON Size*Sc,3,3
2090  SUBEND
```

```
10    ! -----------------------------------------------
20    !
30    ! IBASIC program:  STATS - Collects statistics.
40    !
50    ! This HP 8711 IBASIC program uses a barcode reader.
60    ! Displays running average of selected BPF passbands.
70    ! Finds linear avg of log data (ie Avg of 1dB & 5dB =3)
80    ! Expects to see BARCODE with the following format:
90    ! Model Number (6 char), space, Serial Number (5 char)
100   ! Valid Models:  BPF175, BPF200, SAW134
110   ! REV A.01.00    930615.JVV
120   !
130   ! -----------------------------------------------
140   !
150 Init: !
160   COM /Hpib/ @Rfna
170   COM Csub_loaded
180   DIM A(1:1601),M(1:1601)
190   INTEGER Points,N,I,Chan
200   Points=201 ! # of trace points
210   Chan=2
220   ASSIGN @Rfna TO 800
230   IF NOT Csub_loaded THEN
240      LOADSUB Read_fdata FROM "XFER:MEM 0,0"
250      LOADSUB Write_fmem FROM "XFER:MEM 0,0"
260      Csub_loaded=1
270   END IF
280   OUTPUT @Rfna;"SYST:PRES;*OPC?"
290   ENTER @Rfna;Opc
300   OUTPUT @Rfna;"DISP:PROG UPP"
310   GINIT
320   GCLEAR
330   OUTPUT @Rfna;"DISP:ANN:MESS:STAT 0"
340   OUTPUT @Rfna;"SENS1:STAT OFF;:SENS2:STAT ON"
350   OUTPUT @Rfna;"SENS2:SWE:POIN ";Points   ! points
360   OUTPUT @Rfna;"DISP:WIND2:TRAC:Y:RPOS 9;PDIV 1 DB;*OPC?"
370   ENTER @Rfna;Opc
380   N=0
390 Setup: !
400   LOOP
410      GOSUB Scan_next
420      ON KEY 1 LABEL " AVER THIS DATA" GOSUB Avg_this
430      ON KEY 3 LABEL "SCAN      ANOTHER" GOSUB Scan_next
440      ON KEY 5 LABEL "DONE" GOSUB Exit
450      LOOP
460         DISP "SELECT A SOFTKEY."
470         WAIT 1
480         DISP
490         WAIT .3
```

```
500       END LOOP
510    END LOOP
520    !
530 Exit:  !
540    CLEAR SCREEN
550    DISP "PROGRAM PAUSED!"
560    LOCAL @Rfna
570    PAUSE
580    RETURN
590    !
600 Scan_next:  !
610    LOOP
620       Scan_dut(Model$,Serial$,Cent$,Span$,Loss$)
630       IF Model$="ABORT" THEN GOTO Exit
640       IF NOT N THEN Curr_model$=Model$
650    EXIT IF Model$=Curr_model$
660       DISP "Inconsistent Model #, Try again!"
670       BEEP 2100,.1
680       WAIT 1
690    END LOOP
700    CLEAR SCREEN
710    PRINT TABXY(1,4);"Device currently under test:"
720    PRINT "Model # ";Model$;"   Serial # ";Serial$
730    PRINT TABXY(1,6);"# Avg'd:";N
740    PRINT TABXY(1,7);"Status of Serial # "&Serial$&": MEASURING
 "
750    GOSUB Set_stim
760    RETURN
770    !
780 Avg_this:  !
790    PRINT TABXY(1,7);"Status of Serial # "&Serial$&": READING D
ATA"
800    Read_fdata(Chan,A(*))
810    N=N+1
820    PRINT TABXY(1,7);"Status of Serial # "&Serial$&": AVERAGING
 "
830    IF N=1 THEN
840       MAT M= A
850       OUTPUT @Rfna;"TRAC CH2SMEM,CH2SDATA"
860       OUTPUT @Rfna;"CALC2:MATH (IMPL);:DISP:WIND2:TRAC1 ON;TRAC2
 ON;*WAI"
870       OUTPUT @Rfna;"ABOR;:INIT2:CONT ON;*WAI"
880    ELSE
890       FOR I=1 TO Points
900          M(I)=(N-1)/N*M(I)+A(I)/N
910       NEXT I
920    END IF
930    PRINT TABXY(1,6);"# Averaged:";N
940    PRINT TABXY(1,7);"Status of Serial # "&Serial$&": WRITING D
ATA"
950    Write_fmem(Chan,M(*))
```

```
960   PRINT TABXY(1,7);"Status of Serial # "&Serial$&": AVG COMPL
ETE"
970   GOSUB Scan_next
980   RETURN
990   !
1000 Set_stim:! Set Freqs
1010  OUTPUT @Rfna;"DISP:ANN:FREQ:MODE CSPAN"
1020  OUTPUT @Rfna;"SENS:FREQ:CENT "&Csnt$&" MHZ;SPAN "&Span$&"
MHZ"
1030  OUTPUT @Rfna;"DISP:WIND2:TRAC:Y:RLEV -"&Loss$&" DB;*OPC?"
1040  ENTER @Rfna;Opc
1050  RETURN
1060  !
1070  END
1080  !
1090  ! #########  SUBPROGRAMS  #########
1100  !
1110 Scan_dut:SUB Scan_dut(Model$,Serial$,Cent$,Span$,Loss$)
1120     ALLOCATE Scan$[80]
1130     LOOP
1140        Invalid=0
1150        Scan$="ABORT"
1160        Scan$="BPF175 12345" !####### These 3 lines for demo on
ly
1170        S$=VAL$(RND*1.E+9)   !####### Generates random S/N
1180        Scan$[8,12]=S$[3,7]  !####### Delete all to enable abor
t.
1190        BEEP 500,.05
1200        INPUT "Connect & scan DUT or leave blank to exit.",Sca
n$ !SCAN BARCODE
1210        IF LEN(Scan$)<12 THEN  ! Valid device needs 12 char.
1220           Invalid=1
1230        ELSE
1240           Model$=Scan$[1,6]
1250           SELECT UPC$(TRIM$(Model$))
1260           CASE "BPF175","BPF177"
1270              RESTORE F1
1280           CASE "BPF200"
1290              RESTORE F2
1300           CASE "SAW134"
1310              RESTORE F3
1320           CASE ELSE
1330              Invalid=1
1340           END SELECT
1350        END IF
1360     EXIT IF NOT Invalid
1370        IF POS(UPC$(Scan$),"ABORT") THEN
1380           Modsl$="ABORT"
1390           SUBEXIT
1400        END IF
1410        DISP Scan$;" <<--is INVALID!  Try again."
```

```
1420         BEEP 1500,.2
1430         WAIT 1
1440      END LOOP
1450      BEEP 3000,.03
1460      Serial$=Scan$[8,12]
1470      READ Cent$,Span$,Loss$
1480      ! Data format: Center, Span, Loss
1490 F1: DATA 175,50,2  ! 175 MHz BPF
1500 F2: DATA 200,12,1  ! 200 MHz BPF
1510 F3: DATA 134,15,22  ! 134 MHz SAW BPF
1520  SUBEND
```

DATALOG — Using Bar Code Reader

```
10    ! -----------------------------------------------
20    !
30    ! IBASIC program:  DATALOG - Logs trace data
40    !
50    ! This HP 8711 IBASIC program uses a barcode reader.
60    ! Stores ASCII trace data in internal memory until full.
70    ! Then copies stored files to disc.
80    ! Expects to see BARCODE with the following format:
90    ! Model Number (6 char), space, Serial Number (5 char)
100   ! Valid Models:  BPF175, BPF200, SAW134
110   ! REV A.01.00    930615.JVV
120   !
130   ! -----------------------------------------------
140   !
150 Init:  !
160     COM /Hpib/ @Rfna
170   !
180     IF POS(SYSTEM$("SYSTEM ID"),"HP 871") THEN
190       ASSIGN @Rfna TO 800
200     ELSE
210       ASSIGN @Rfna TO 716
220       ABORT 7
230       CLEAR 716
240     END IF
250   !
260     OUTPUT @Rfna;"SYST:PRES;*OPC?"
270     ENTER @Rfna;Opc
280     OUTPUT @Rfna;"DISP:PROG UPP"
290     GINIT
300     GCLEAR
310     GOSUB Warning! May be deleted
320     OUTPUT @Rfna;"DISP:ANN:MESS:STAT 0"
330     OUTPUT @Rfna;"SENS1:STAT OFF;:SENS2:STAT ON"
340     OUTPUT @Rfna;"SENS2:SWE:POIN 201" ! 201 points
350     OUTPUT @Rfna;"DISP:WIND2:TRAC:Y:RPOS 9"
360     OUTPUT @Rfna;"MMEM:MSIS 'MEM:'"
370     OUTPUT @Rfna;"MMEM:INIT 'MEM:',DOS"
380     OUTPUT @Rfna;"MMEM:STOR:STAT:IST OFF;CORR OFF;TRAC OFF;*OPC?"
390     ENTER @Rfna;Opc
400 Setup:  !
410     LOOP
420       GOSUB Scan_next
430       ON KEY 1 LABEL "STORE THIS DATA" GOSUB Stor_mem
440       ON KEY 2 LABEL "STORE MEM TO DISK" CALL Store_disk
450       ON KEY 3 LABEL "SCAN      ANOTHER" GOSUB Scan_next
460       ON KEY 5 LABEL "DONE" GOSUB Exit
470       LOOP
480         DISP "SELECT A SOFTKEY"
490         WAIT 1
```

```
500       DISP
510       WAIT .3
520     END LOOP
530   END LOOP
540  !
550 Exit:   !
560   Store_disk
570   CLEAR SCREEN
580   DISP "PROGRAM PAUSED!"
590   LOCAL @Rfna
600   PAUSE
610   RETURN
620  !
630 Scan_next:   !
640   Scan_dut(Model$,Serial$,Cent$,Span$,Loss$)
650   IF Model$="ABORT" THEN GOTO Exit
660   CLEAR SCREEN
670   PRINT TABXY(1,3);"Device currently under test:"
680   PRINT
690   PRINT "Model # ";Model$;"   Serial # ";Serial$
700   PRINT TABXY(1,7);"Status of Serial # "&Serial$&": MEASURING
 "
710   GOSUB Set_stim
720   RETURN
730  !
740 Stor_mem:   !
750   PRINT TABXY(1,7);"Status of Serial # "&Serial$&": STORING T
O RAM"
760   Store_ram(Model$,Serial$)
770   PRINT TABXY(1,7);"Status of Serial # "&Serial$&": STORING D
ONE  "
780   GOSUB Scan_next
790   RETURN
800  !
810 Set_stim:  ! Set Freqs
820   OUTPUT @Rfna;"DISP:ANN:FREQ:MODE CSPAN"
830   OUTPUT @Rfna;"SENS:FREQ:CENT "&Cent$&" MHZ;SPAN "&Span$&"
 MHZ"
840   OUTPUT @Rfna;"DISP:WIND2:TRAC:Y:RLEV -"&Loss$&" DB;*OPC?"
850   ENTER @Rfna;Opc
860   RETURN
870  !
880 Warning:  !
890   BEEP 3000,.3
900   PRINT TABXY(15,4);"WARNING!"
910   PRINT "This program will initialize the INTERNAL memory."
920   PRINT "All internally saved files will be lost!"
930   PRINT
940   PRINT "Do you wish to continue?  (y/N)"
950   INPUT "Continue?",Ans$
960   CLEAR SCREEN
```

```
970  IF UPC$(Ans$[1,1])="Y" THEN RETURN
980  END
990  !
1000 ! #########  SUBPROGRAMS  #########
1010 !
1020 Scan_dut:SUB Scan_dut(Model$,Serial$,Cent$,Span$,Loss$)
1030    ALLOCATE Scan$[80]
1040    LOOP
1050      Invalid=0
1060      Scan$="ABORT"
1070      Scan$="BPF175 12345"!####### These 3 lines for demo only
1080      S$=VAL$(RND*1.E+9)!####### Generates random S/N
1090      Scan$[8,12]=S$[3,7]!####### Delete all to enable abort.
1100      BEEP 500,.05
1110      INPUT "Connect & scan DUT or leave blank to exit.",Scan$
!SCAN BARCODE
1120      IF LEN(Scan$)<12 THEN ! Valid device needs 12 char.
1130        Invalid=1
1140      ELSE
1150        Model$=Scan$[1,6]
1160        SELECT UPC$(TRIM$(Model$))
1170        CASE "BPF175","BPF177"
1180          RESTORE F1
1190        CASE "BPF200"
1200          RESTORE F2
1210        CASE "SAW134"
1220          RESTORE F3
1230        CASE ELSE
1240          Invalid=1
1250        END SELECT
1260      END IF
1270    EXIT IF NOT Invalid
1280      IF POS(UPC$(Scan$),"ABORT") THEN
1290        Model$="ABORT"
1300        SUBEXIT
1310      END IF
1320      DISP Scan$;" <<--is INVALID!  Try again."
1330      BEEP 1500,.2
1340      WAIT 1
1350    END LOOP
1360    BEEP 3000,.03
1370    Serial$=Scan$[8,12]
1380    READ Cent$,Span$,Loss$
1390 ! Data format: Center, Span, Loss
1400 F1:DATA 175,300,2    ! 175 MHz BPF
1410 F2:DATA 200,100,1    ! 200 MHz BPF
1420 F3:DATA 134,30,22    ! 134 MHz SAW BPF
1430  SUBEND
1440 !
1450  SUB Store_ram(Model$,Serial$)
1460    COM /Hpib/ @Rfna
```

```
1470     Id$=Model$[3,4]&"_"&Serial$! 2 unique chars + Ser
1480     ALLOCATE Err$[80]
1490     DISABLE
1500     REPEAT
1510       OUTPUT @Rfna;"*CLS"
1520       OUTPUT @Rfna;"MMEM:MSIS 'MEM:'"
1530       OUTPUT @Rfna;"MMEM:STOR:TRAC CH2FDATA,'"&Id$&"';*WAI"
1540       OUTPUT @Rfna;"SYST:ERR?"
1550       ENTER @Rfna;Err$
1560       SELECT VAL(Err$)
1570       CASE 0! No Problem
1580       CASE -254! Internal Mem full
1590         CALL Store_disk
1600       CASE -257! dupl file name
1610         OUTPUT @Rfna;"MMEM:DEL '"&Id$&"';*WAI"!ERASE OLD
1620       CASE ELSE
1630         BEEP 2000,.5
1640         DISP Err$;
1650         INPUT " Fix, Press ENTER",Ans$
1660       END SELECT
1670     UNTIL VAL(Err$)=0
1680     ENABLE
1690   SUBEND
1700 !
1710   SUB Store_disk
1720     COM /Hpib/ @Rfna
1730     ALLOCATE Err$[80]
1740     BEEP 700,.1
1750     DISP "Standby: Transferring internal files to disk."
1760     LOOP
1770       OUTPUT @Rfna;"*CLS"
1780       OUTPUT @Rfna;"MMEM:COPY '*.*' , 'INT:';*WAI"
1790       OUTPUT @Rfna;"SYST:ERR?"
1800       ENTER @Rfna;Err$
1810     EXIT IF NOT VAL(Err$)
1820       GOSUB Trap_err
1830     END LOOP
1840     OUTPUT @Rfna;"MMEM:MSIS 'MEM:';DEL '*.*'"
1850     SUBEXIT
1860 !
1870 Trap_err:   !
1880     IF VAL(Err$)=-250 THEN SUBEXIT! no file to xfer
1890     BEEP 2000,.5
1900     CLEAR SCREEN
1910     PRINT TABXY(1,4);"DISK ERROR DETECTED"
1920     PRINT "*** "&Err$&" ***"
1930     INPUT "Fix above problem, then press ENTER",Ans$
1940     CLEAR SCREEN
1950   SUBEND
```

YES

NO

RUN

PAUSE

ABORT

CONT

ENTER *(blank)*

BENCH 4500 *(Station)*

BENCH 5300 *(Station)*

J VALLELUNGA

LENE CORRIGAN

BPF175 00123

BPF175 00156

BPF175 00560

BPF175 00758

BPF175 01023

BPF200 00045

BPF200 00059

BPF200 0077

SAW134 00707

SAW134 00721

SAW134 00776

Figure 11-1. Sample Bar Codes

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